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SCIENCE 14

MODULE 4 • MATTER AND ENERGY IN THE BIOSPHERE

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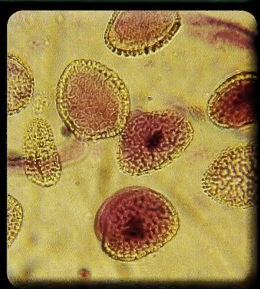

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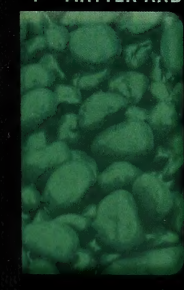

Learning Technologies Branch

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SCIENCE 14

MODULE 4 ■ MATTER AND ENERGY IN THE BIOSPHERE

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Science 14
Module 4: Matter and Energy in the Biosphere
Student Module Booklet
Learning Technologies Branch
ISBN 0-7741-2543-8

The Learning Technologies Branch acknowledges with appreciation the Alberta Distance Learning Centre and Pembina Hills Regional Division No. 7 for their review of this Student Module Booklet.

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	
General Public	
Other	

You may find the following Internet sites useful:

- Alberta Learning, **http://www.learning.gov.ab.ca**
- Learning Technologies Branch, **http://www.learning.gov.ab.ca/ltb**
- Learning Resources Centre, **http://www.lrc.learning.gov.ab.ca**

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Welcome to

SCIENCE 14

Science 14 contains four modules.
You should work through the modules in order (from 1 to 4) because concepts and skills introduced in one module will be reinforced, extended, and applied in later modules.

MODULE 1
■ INVESTIGATING PROPERTIES OF MATTER ■

MODULE 2
■ ENERGY TRANSFER TECHNOLOGIES ■

MODULE 3
■ FROM LIFE TO LIFESTYLE ■

MODULE 4
■ MATTER AND ENERGY IN THE BIOSPHERE ■

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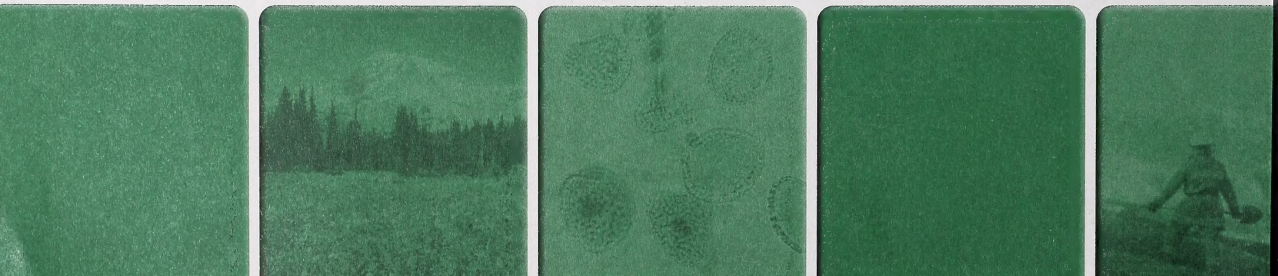

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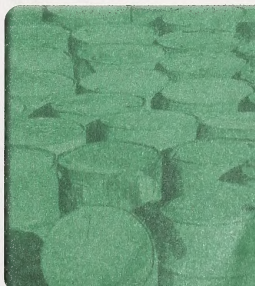
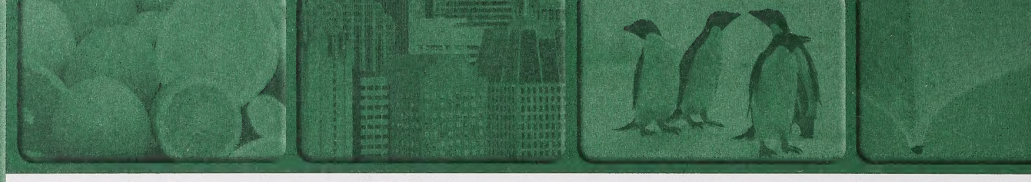
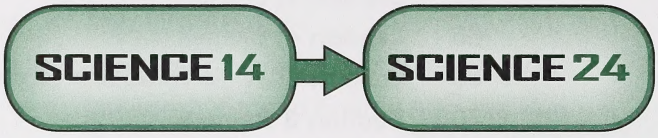




Course Features

The Science 14–24 Program

Science 14 is the first course in the Science 14–24 sequence of courses. If you successfully complete each of these five-credit courses, you will meet the minimum requirement in science for an Alberta high school diploma.



The Science 14–24 sequence is designed for students whose needs, interests, and abilities focus on basic science understanding. This course sequence emphasizes scientific and related technological knowledge and skills that will enable you to understand and interpret the world around you.

Consult your teacher or counsellor for the latest information on Science 14. Also, if you have access to the Internet, you can find out more about Science 14 and high school requirements at the Alberta Learning website.

http://www.learning.gov.ab.ca

This Science 14 course consists of four modules. Each module consists of one Student Module Booklet and two Assignment Booklets. The booklet you are presently reading is called a Student Module Booklet. It will show you, step by step, how to advance through each module.

Resources You Will Need

Textbook

To complete the course, you will need the textbook *Science.Connect 1*.

Multimedia

Attached to the inside cover of the textbook and to Module 1 of this course are multimedia CDs. These CDs contain multimedia segments designed to help you better understand particular concepts presented in this course. Ask your teacher, friend, or family member if you need help using these CDs.

Looseleaf Binder or Notebook

Because response lines are not provided in the Student Module Booklets, you will need a looseleaf binder or notebook to respond to questions and complete charts. It's important to keep your lined paper handy as you work through the material and to keep your responses together in a binder for review purposes later.

Materials and Apparatus

The modules include numerous science activities and investigations that require materials and apparatus. A lab kit is not needed to complete this Science 14 course. Many of the activities and investigations are set up so you can complete them using common household materials. Some investigations, however, do require lab material and apparatus. These investigations are set up with a Part A and a Part B. If you have access to a supervised laboratory facility, you may complete Part A of these investigations. If you do not have access, Part B will provide you with an alternate pathway.

Visual Cues

You will find many visual cues throughout this course. Colour is used to highlight the important terms that are defined in the Glossary of the Appendix. You will also encounter some icons in the margins. Read the following explanations to find out what each icon prompts you to do.

Refer to the textbook.

Use the Internet.
Note: Any website given is subject to change.

Refer to the multimedia CD given in Module 1.

Pay special attention to the safety precautions mentioned.

Refer to the multimedia CD given in the textbook.

Answer questions in the Assignment Booklet.

Module Overview

Do you enjoy camping? Have you camped in any of Alberta's provincial or national parks recently? These parks show what much of Alberta looked like only 100 years ago—parts grassland, parts poplar forest, and parts spruce forest. Back then, animals and the small human population lived without altering the general appearance of their environment.

Today, there are large cities with buildings, concrete streets, and parking lots. Even most areas outside the cities have changed dramatically. Areas have been cleared for farming and ranching; rivers have been dammed to produce electricity; and large areas of forest have been cut and managed for human use.

In this module you will first discover how energy from the Sun is captured by plants and converted into chemical energy. You will describe how chemical energy is converted into mechanical energy and heat energy as it passes through the food web. You will then analyze how populations interact within their own population, with other populations, and with the abiotic environment. Next, you will identify what factors of the abiotic environment determine what life exists in different parts of the planet. Lastly, you will identify environmental problems that have been created by humans, and you will analyze how these problems might be corrected.

Assessment and Feedback

This module, Matter and Energy in the Biosphere, has four sections. Within each section, your work is grouped into lessons. Within the lessons, there are readings, activities, investigations, and questions for you to do. By completing these lessons, you will discover scientific concepts and skills, practise or apply what you have learned, and develop a positive attitude toward science.

Suggested answers to the questions are provided in the Appendix of this Student Module Booklet. They will provide you with immediate feedback to the questions you complete in the lessons.

At several points in this Student Module Booklet, you will be directed to the accompanying Assignment Booklets. Your grading in this module is based on the assignments you submit for assessment. In this module you are expected to complete four section assignments.

The mark distribution is as follows:

Assignment Booklet 1A	
Section 1 Assignment	46 marks
Section 2 Assignment	28 marks
Assignment Booklet 1B	
Section 3 Assignment	30 marks
Section 4 Assignment	26 marks
Total	**130 marks**

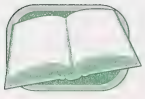
You will be asked to submit each Assignment Booklet to your teacher once it is completed. Your teacher will then mark your Assignment Booklet and give you feedback as to how you are doing. Once you get your Assignment Booklet back, be sure you review your teacher's comments and correct any errors you made.

Section 1

THE WEB OF LIFE

Did you know that the energy for most living things comes from the Sun? Plants store energy directly from the Sun. Animals and humans consume plants to obtain energy from these plants. Some animals and humans consume other animals to obtain energy from these animals. The energy that is passed on by these animals come from plants and originally from the Sun.

In this section you will discover that all living things need a constant supply of energy and that the Sun is the source of energy for all living things directly and indirectly. You will examine how energy is transferred from one organism to another and analyze why less energy is available as you move up the food chain. You will then describe how water, carbon dioxide and oxygen, and nitrogen cycle in the environment.



Read the introduction to "Chapter 12: The Web of Life" on pages 236 and 237 of the textbook. Note the points in "What You Will Learn," "Why It Is Important," and "Skills You Will Use." These points provide a summary of what you will be covering in this section.

Lesson 1

What Is Energy?

The children in the photograph are using energy. The semi in the other photograph is also using energy. Where does the energy the children and the semi are using come from? What is the difference between the energy used by the children and the energy used by the semi?

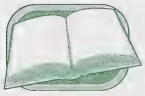
Energy use 100 years ago was much different than energy use today. Study the photographs on pages 236 and 237 of the textbook. They show how energy was used in the early 1900s and how it is used today.

1. Where did the energy used in farming in the early 1900s come from? Where does the energy used in farming today come from?

Check your answer on page 96 of the Appendix.

Starting Point Activity

How Have Things Changed?

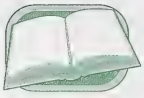


Not only has farming changed over the past 100 years, city life has changed dramatically as well. Read the activity on page 237 of the textbook. Then answer the following questions.

2. Name two features that are different in the two pictures of Red Deer.

3. Name two new technologies people have developed that are shown in the picture of Red Deer in 2000.

Check your answers on pages 96 and 97 of the Appendix.



What is energy? Module 2 showed you that energy is not like matter. It does not have mass or take up space. To learn what energy is and where energy comes from, read "What Is Energy" and "Energy Comes from the Sun" on page 238 of the textbook.

4. According to the textbook, what is energy?

5. Where do humans get their energy?

6. Humans get their energy in the form of _____.

7. Where do plants get their energy?

8. The substance most organisms use as a source of chemical energy is _____.

9. What two types of energy does chemical energy transforms into through cellular respiration?

10. What two processes do the equations in Figures 12.1 and 12.2 represent?

Check your answers on page 97 of the Appendix.

Find Out
Activity

Forms of Energy

Read the entire activity on page 239 of the textbook. Think about what is happening in each photograph and what may have been used to produce what is in each photograph.

11. Make a list of the forms of energy you can see in the two photographs on page 239 of the textbook and the four photographs on page 237. Also state what is giving the energy or how the energy is used.

12. What are the names of the forms of energy involved in the activities in these photographs?

13. Answer questions 2 and 3 of "What Did You Find Out?" on page 239.

CHECK Check your answers on page 97 and 98 of the Appendix.

You have now completed the concepts for this lesson. Do the following questions to review what you studied.

14. Answer questions 1 and 3 of "Check Your Understanding" on page 239 of the textbook.

CHECK Check your answer on page 98 and 99 of the Appendix.

Go to ... Go to pages 1 and 2 of Assignment Booklet 4A and answer questions 1 to 6.

Lesson 2

Storing Energy from the Sun

Plants use energy from the Sun to produce glucose. This allows them to carry out their life activities—mainly for growth and reproduction. Plants also make more glucose than they need to carry out their life activities. This extra glucose is stored as starch. The crop in the photograph is storing the light energy from the Sun as starch in the seeds, stems, leaves, and roots.

Plants and animals need energy to carry on their life activities. Turn to page 240 of the textbook and read the first two paragraphs of "Storing Energy from the Sun."

1. Complete the following statements.

   a. Plants produce glucose and store excess glucose as _____.

   b. Your body breaks down starch into _____ during digestion.

   c. The chemical energy in glucose is released by the _____ in your cells.

2. Name two food items you eat that contain starch.

CHECK Check your answers on page 99 of the Appendix.

Recall that photosynthesis is the process used by plants to produce glucose. Also, recall that cellular respiration is the process that both plant and animal cells use to convert glucose to energy for the cells' activities. To review these processes, insert the *Science.Connect 1 Student Multimedia* CD into your computer. Work through the *PSCR* applet from the Photosynthesis folder.

Investigation

12-A: How Do Plants Store Energy from the Sun?

Read the entire investigation on pages 240 and 241 of the textbook. This investigation involves covering a leaf of a plant, such as that of a geranium, and leaving it in the Sun for 24 hours. A test for the presence of starch using iodine will then be done. You will compare the effect of iodine on an uncovered area with the effect of iodine on a covered area.

3. Write your hypothesis.

Check your answer on page 99 of the Appendix.

If you have access to a supervised laboratory, do **Part A**. If you don't have access, do **Part B**.

Part A

Complete the investigation as directed on pages 240 and 241 of the textbook. **Carefully follow the safety precautions mentioned.**

4. Answer the following on page 241 of the textbook.
   a. questions 1 and 2 of "Analyze"
   b. questions 3, 4, and 5 of "Conclude and Apply"
   c. questions 6 and 7 of "Extend Your Knowledge"

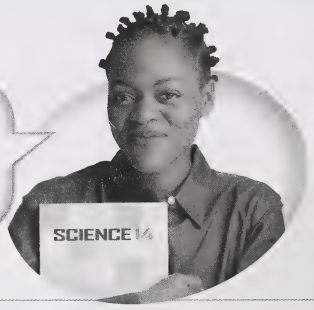
Check your answers on pages 99 and 100 of the Appendix.

Part B

One student completed Investigation 12-A. This student wrote the following observations:

- The part of the leaf that was exposed to sunlight turned a dark colour when iodine was added.
- The part of the leaf that was covered by the dark paper became the yellow (or orange-red) colour of the iodine when the iodine was added.

Answer question 4 in **Part A** using this student's observations and the information in the investigation on pages 240 and 241 of the textbook.



The following information should help you gain a more complete understanding of what occurred in Investigation 12-A.

In Investigation 12-A, the part of the leaf that is exposed to sunlight turns a dark colour when iodine is added. The iodine test indicates the presence of starch by turning black. Plants produce glucose when the Sun is shining and convert any excess glucose to starch. The starch is stored for later use. When you cover part of the leaf with dark paper, that part of the leaf does not get any sunlight, so it does not have excess glucose to store as starch. In addition, the plant has to convert any starch already present back into glucose to use for its cell's activities.

You have just completed the concepts for this lesson. Do the following questions to check what you covered.

5. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 241 of the textbook.

CHECK Check your answers on page 100 of the Appendix.

Go to ... Go to pages 2 and 3 of Assignment Booklet 4A and answer questions 7 to 11.

Lesson 3

Energy Pathways in an Ecosystem

The field in this photograph looks fairly barren and uninhabited, except for the grasses and trees of course. However, if you were to remain in this field for several hours on a warm summer day, you would notice a number of organisms that live within the plants. You would also see some dead wood and rocks. Because some plants or animals live on or in the dead wood and under the rocks, all these items are part of the **ecosystem**.

Turn to page 242 of the textbook and read the introductory paragraphs of "Energy Pathways in an Ecosystem."

1. What is an ecosystem?

2. An ecosystem contains both _____ and _____ components.

3. Give three examples for each of the two components of an ecosystem.

CHECK Check your answers on page 100 of the Appendix.

An ecosystem consists of many relationships between its parts. These relationships often are based on feeding, since food is essential to the survival of an organism. A model showing how energy and matter pass through an ecosystem is called a **food chain**.

Turn to page 242 of the textbook and read "Food Chains."

4. What is a producer in a food chain?

5. Name the producers in the food chain in Figure 12.3.

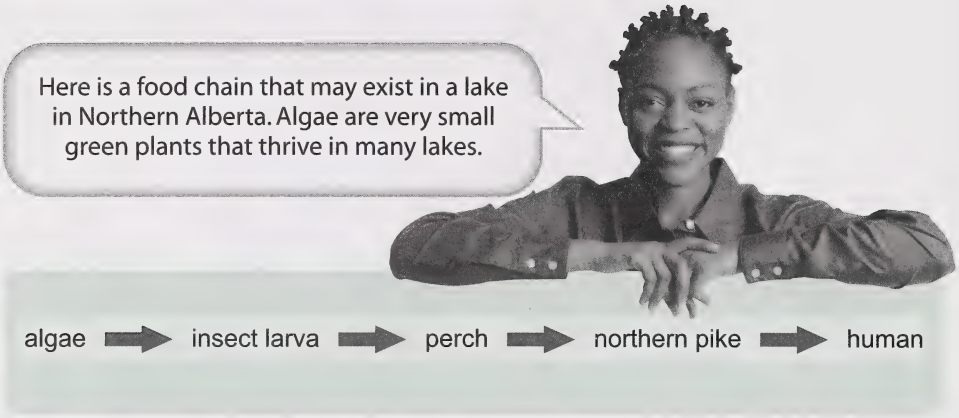
6. What is a consumer?

7. Name the two consumers in the food chain in Figure 12.3.

8. Which way does the energy travel in the food chain in Figure 12.3?

9. What name is given to the group of living things that break down wastes and the bodies of dead plants and animals?

CHECK Check your answers on pages 100 and 101 of the Appendix.


Here is a food chain that may exist in a lake in Northern Alberta. Algae are very small green plants that thrive in many lakes.
algae
insect larva
perch
northern pike
human

10. Name the producer(s) in the food chain.

11. Name the consumer(s) in the food chain.

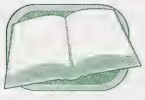
12. Which organism(s) directly provide energy to the northern pike?

13. Where does the energy for this food chain come from originally?

Check your answers on page 101 of the Appendix.

The previous food chain shows how energy is passed from one organism to another. A food chain can be completed for any food you eat. In the next activity you will compare food chains for foods people ate 100 years ago to food chains for foods you eat today.

Food and You



Read the entire activity on page 243 of the textbook. In place of picking five foods, create food chains for selected foods from the list at the bottom of the page.

14. Create a food chain for each of the following foods that people ate 100 years ago. The first one is partially completed for you.

Bannock

Sun ➡ *bannock (corn, oatmeal, or barley meal)* ➡
Sun ➡ *bison (animal fat)* ➡

Cabbage

Rabbit

15. Answer question 1 of "What Did You Find Out?"

16. Create food chains for each of the following foods that you may eat today.

    - whole-wheat bread (consider the wheat only)
    - lettuce
    - fish

17. How are the food chains for foods you eat today similar to the food chains for foods that people ate 100 years ago?

Check your answers on page 101 of the Appendix.

In the food chains you just created, only one food for the final consumer was used at one time. However, most organisms have several predators. A **food web** shows several food chains—all starting from a producer and ending with a single consumer.

Turn to page 244 of the textbook and read the information in "Food Webs." Study the food web in Figure 12.4 carefully.

18. What is a food web?

19. What is a primary consumer?

20. What is a secondary consumer?

21. What is a tertiary consumer?

22. Use the food web on page 244 to answer the following.

    a. Which organism is the producer?

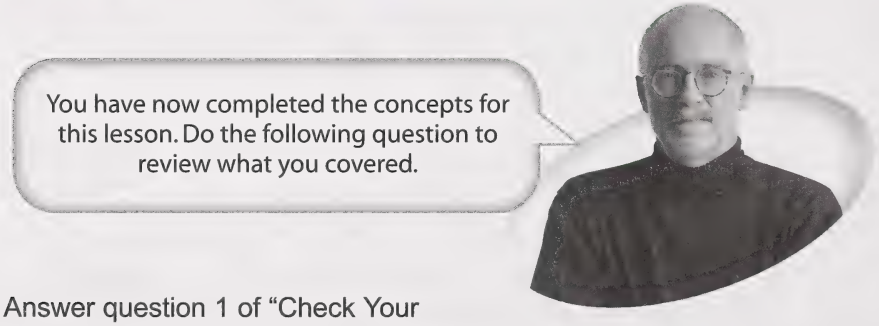
    b. Name the primary consumers.

    c. Name the secondary consumers.

    d. Name the organism that is a tertiary consumer. Are there other tertiary consumers in this food web?

23. Identify any three food chains in the food web on page 244.

CHECK Check your answers on pages 101 and 102 of the Appendix.



24. Answer question 1 of "Check Your Understanding" on page 244 of the textbook.

CHECK Check your answer on page 102 of the Appendix.

Go to ... Go to pages 3 to 5 of Assignment Booklet 4A and answer questions 12 to 19.

Lesson 4

Energy Transfers

Primary consumers eat producers. Secondary consumers eat primary consumers. Tertiary consumers eat secondary consumers. The energy is transferred from one organism to another.

The organisms in a typical food chain can be represented by an **ecological pyramid**. This pyramid somewhat shows the relative numbers of organisms or the amount of energy available at each level.

Turn to page 245 of the textbook and read the introductory paragraphs of "Energy Transfers." Study the ecological pyramid in Figure 12.6.

1. Which organism makes up the base of the pyramid in Figure 12.6?

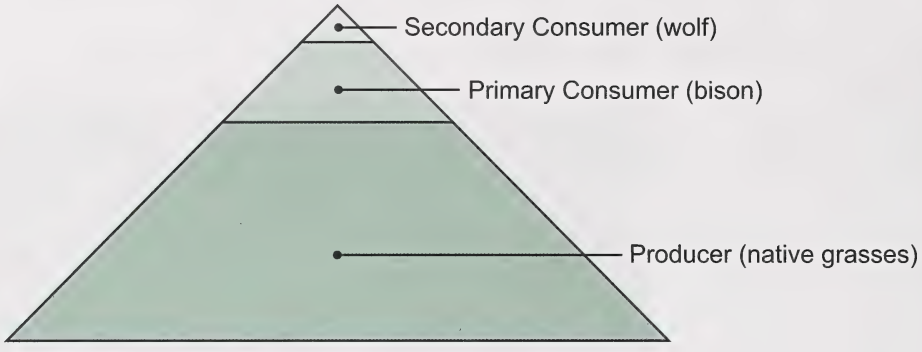
2. Which organism makes up the top of the pyramid in Figure 12.6?

3. Do you think there are more bison or more wolves?

CHECK

Check your answer on page 103 of the Appendix.

To represent the relative number of organisms or the amount of energy available at each level, the size of each level should be about $\frac{1}{10}$ of the previous level. This would look somewhat like the following.



4. What does an ecological pyramid show?

Check your answer on page 103 of the Appendix.

A pyramid is used to show the amount of energy available at each level. You can think of the ecological pyramid as a pyramid of energy. Actually, only about 10% of the energy available at each level is transferred to the next level.

Since only about 10% of the energy at each level is transferred to the next level, you might ask: "What happens to the energy at each level?" To find out, turn to page 247 of the textbook and read "What Happens to the Energy?" Study the diagram in Figure 12.7 closely.

5. Draw a pyramid of energy similar to the one above using the following food chain. The energy pyramid you draw should show only relative numbers and positions of the organisms.

grass → mouse → hawk

6. Is all the grass in a given natural area always eaten by primary consumers?

7. List three functions for which organisms use energy.

8. What happens to the energy in an organism when it dies?

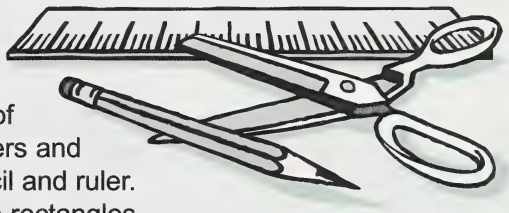
9. In what form is some of an organism's energy lost?

Check your answers on page 103 of the Appendix.

Investigation

12-B: Pyramid of Energy

Read the entire investigation on page 246 of the textbook.



Carefully follow the instructions in "What to Do." Once you have completed step 4, use one of the rectangles that represents the amount of energy available to secondary consumers and divide it into 10 rectangles using a pencil and ruler. Cut out these rectangles. Each of these rectangles represents the amount of energy available to tertiary consumers.

10. Draw a pyramid of energy representing a producer, primary consumer, secondary consumer, and tertiary consumer. Label each level appropriately. Use your four sets of rectangles from the investigation to help you see the relative amount of energy that is available at each level.

11. How do the sizes of the rectangles in each set relate to the relative amount of energy available at each level.

12. Answer questions 1, 2, and 3 of "Analyze."

13. Answer questions 4 and 5 of "Extend Your Skills."

Check your answers on page 104 of the Appendix.

You have now completed the concepts for this lesson. Check your understanding by answering the following questions.

14. Complete questions 1, 3, and 4 of "Check Your Understanding" on page 247 of the textbook.

CHECK Check your answers on page 105 of the Appendix.

Go to ... Go to pages 5 and 6 of Assignment Booklet 4A and answer questions 20 to 22.

Lesson 5

The Cycles of Matter

You know that water falls as rain from the sky. Where does this water come from? Water evaporates, rises and condenses as water droplets in the clouds, and then returns to the ground as rain. This is called the water cycle. The water cycle is one of the several cycles of matter that occur in nature. Matter passes through a number of stages and some parts are returned to Earth's surface to be used by living organisms again.

The water cycle is of great importance to survival on Earth. All living organisms require water. It is very important that water is returned to Earth's surface in any form of precipitation. Without rain, snow, and so on, Earth's surface would dry out.

To learn more about the water cycle and cycles of matter, turn to page 248 of the textbook and read the introductory information of "The Cycles of Matter." Carefully study Figure 12.8.

1. How does plant matter move through the food chains from organism to organism?

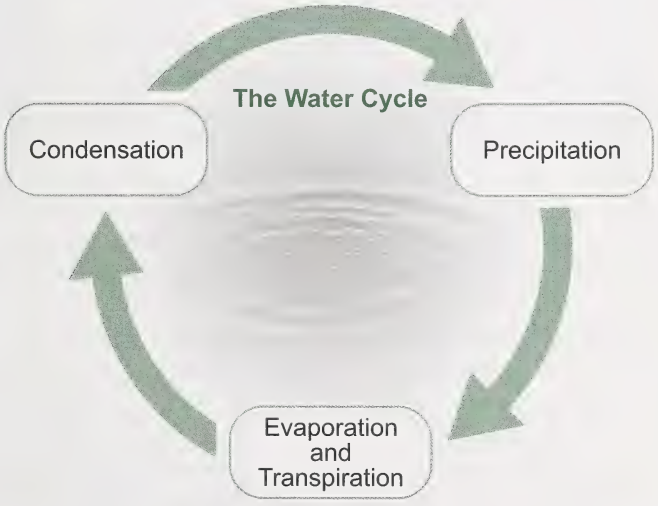
2. Name the two main ways in which water enters the atmosphere to become precipitation.

3. After it rains on land, list three things that happen to the water from the rain.

4. What is the driving force behind all cycles of matter? **Note:** Read "Did You Know?"

Check your answers on page 105 of the Appendix.

For more information on the water cycle, insert the *Science.Connect 1 Student Multimedia* CD into your computer. Launch the applet *Water* from the Water folder. Follow the instructions in the applet, and answer the following questions.



5. What percent of all available water is fresh water?

6. When plants recycle water into the atmosphere, the water is _____.

7. What is surface runoff?

8. Which two processes purify water?

9. What is evaporation?

10. What percentage of water in the atmosphere is from transpiration?

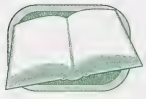
11. What is condensation?

12. What are clouds composed of?

13. Why is it okay to say that dinosaurs once played in the water in your drinking glass?

Check your answers on pages 105 and 106 of the Appendix.

Carbon and oxygen also cycle on Earth. In the carbon and oxygen cycles, carbon and oxygen are recycled through the ecosystem. Although it is called the carbon and oxygen cycles, carbon is recycled through carbon dioxide.



Turn to page 249 of the textbook and study Figure 12.9. It illustrates the carbon and oxygen cycles. Then read the text at the bottom of the page.

14. How do carbon dioxide and oxygen cycle through photosynthesis?

15. What gas is released during cellular respiration?

16. Decomposition uses _____ and releases _____ into the atmosphere.

17. Name four ways through which carbon dioxide is returned to the atmosphere.

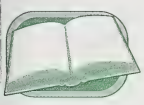
18. The following statements describe the carbon and oxygen cycles but are in the wrong order. Rewrite the statements in the order in which the process occurs, starting with the use of carbon dioxide from the air by plants.

    - The carbon dioxide is released into the atmosphere to be used again by plants to make more glucose.
    - New plants and animals continue the carbon and oxygen cycles.
    - In the carbon and oxygen cycles, plants use carbon dioxide from the atmosphere to make glucose through the process of photosynthesis.
    - During cellular respiration, glucose and oxygen are converted into carbon dioxide, water, and energy.
    - During photosynthesis, plants give off oxygen to the atmosphere.
    - Plants and animals die, and decomposers break down their bodies and release carbon dioxide into the atmosphere.

Check your answers on page 106 of the Appendix.

denitrification: the removal of nitrogen or nitrogen groups from a compound

Another cycle that is important to the survival of plants and animals on Earth is the nitrogen cycle. In this cycle nitrogen gas is converted into nitrates. Plants and animals need these nitrates for growth. Nitrogen is returned to the atmosphere by **denitrification** of nitrates by certain bacteria.



Read "The Nitrogen Cycle" on page 250 of the texbook. Study Figure 12.11.

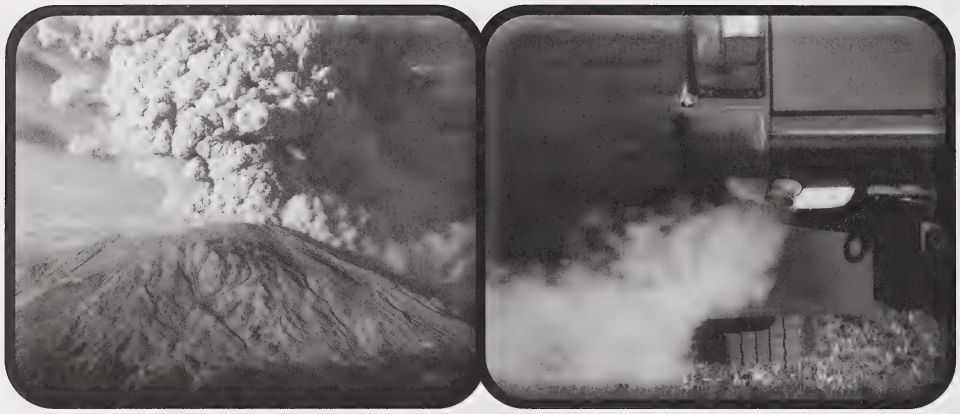
19. How is nitrogen gas in the atmosphere converted into nitrates in the nitrogen cycle?

20. When plants and animals die, nitrogen in their bodies is converted into nitrates by _____ in the _____.

21. In addition to the natural process of putting nitrates into the soil, what else has added nitrates to the soil in recent years?

22. Summarize how nitrogen moves through the nitrogen cycle.

Check your answers on page 107 of the Appendix.



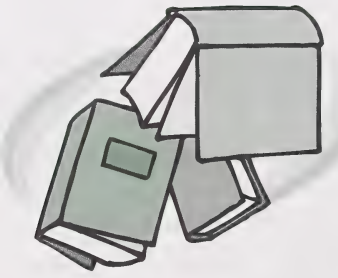
In nature there seems to be a balance in each of the cycles. This balance, however, can be disrupted. Disruptions can occur when too much of one substance is released into the ecosystem through some activity. These activities can be natural (such as volcanic activity and forest fires set by lightning) or they can be caused by humans (such as burning fossil fuels, deforestation, and agriculture). Activities of humans in Alberta 100 or more years ago mostly had very little impact on the natural cycles. Today, with increased population and intensive industrial and farming practices, the effects of humans on the natural cycles is far greater.

Turn to page 251 of the textbook and read "Working with Natural Cycles." You will discover how one activity is different today from what it was like 100 years ago.

23. What do decomposing plants and animal wastes contain?

24. Is it beneficial to spread compost on gardens and animal wastes on fields? Explain.

Check your answers on page 107 of the Appendix.



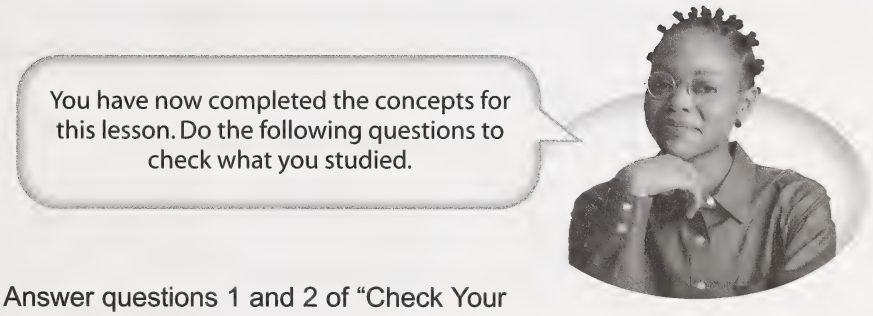
About a hundred years ago a farmer only had a few head of cattle. Today, many farmers have hundreds of head of cattle and feedlots thousands. Nitrates, which are beneficial to plants, can also contaminate soil and water when manure is excessive in a small area.

25. Will cattle wastes become a problem in today's cattle industry? Explain.

26. What could operators of large feedlots do to get rid of their animal wastes?

Check your answers on page 107 of the Appendix.

Use the Internet or your local library to find information on composting and building a composter. You may also want to visit the website given in "Internet Connect" on page 251 of the textbook. It provides information about using worms for composting.



27. Answer questions 1 and 2 of "Check Your Understanding" on page 251 of the textbook.

Check your answers on pages 107 and 108 of the Appendix.

Go to pages 7 and 8 of Assignment Booklet 4A and answer questions 23 to 31.

Section 1 Review

In this section you discovered that all living things need a constant supply of energy and that the Sun is the source of energy for all living things on Earth. You discovered how energy is transferred from one organism to another and that less energy is available as you move up the food chain. You then examined how the water cycle, carbon and oxygen cycles, and nitrogen cycle operate in the ecosystem.

You now know that all energy on Earth comes from the Sun and that a portion of this energy is passed from one organism to another as it moves up the food chain. Through your studies, you categorized organisms as producers, consumers, and decomposers. Do you know where you fit in the food chain?

You have now completed the concepts for this section. To review what you studied, answer the following "Chapter 12 Review" questions on pages 252 and 253 of the textbook. If necessary, go back and read over the parts of this section as you answer the questions.

1. Answer question 1 of "Reviewing Key Terms."

2. Answer questions 3, 7, and 8 of "Understanding Key Ideas."

3. Answer question 11 of "Critical Thinking."

Check your answers on pages 108 and 109 of the Appendix.

Section 2

POPULATIONS

What do you think of when you hear the word *population*? Do you think of the number of people in a large city? Do you think of Earth's population? Biologists think of population in a slightly different way. They think of the number of each species, not just humans, in an environment as the population of that environment.

In this section you will examine how birth rate, death rate, immigration, and emigration determine the size of a population. You will discover that most environments have a carrying capacity for each population. You will then study how abiotic and biotic factors limit the size of a population and how other factors—such as competition, predation, and parasitism—control the size of a population. Lastly, you will examine how human activities can affect the populations of other living things.

Turn to page 255 of the textbook and read "What You Will Learn," "Why It Is Important," and "Skills You Will Use" for further information of what is expected in this section.

Lesson 1

Changing Populations

Jasper Avenue
Edmonton, Alberta
1929

Jasper Avenue
Edmonton, Alberta
2003

The human populations depicted in these two photographs has changed over the past 74 years. The population has changed in size, where the individuals live, where they work, and where they shop. Factors like these help those who study urban populations assess the changes in the population of a city.

The increase in Alberta's human population and in the human population worldwide has raised a number of questions. Where will all the people live? How will food be provided for this expanding population? What pollution problems will be created? How can they be solved?

Turn to pages 254 and 255 of the textbook and read the introduction to "Chapter 13: Populations."

1. Refer to the photographs of Calgary in 1884 (page 254) and Edmonton in 2000 (page 255).

   a. Speculate how the human population in Calgary in 1884 compares to the one in Edmonton in 2000?

   b. How has the environment been affected?

2. Why is it important for you to learn about populations of living organisms?

Check your answers on page 110 of the Appendix.

Starting Point Activity

Threatened Wildlife

Read the entire activity on page 255 of the textbook.

3. Answer questions 1 and 2 of "What to Do." **Note:** You do not need to work in teams. You can find all the information you need using the Internet or your local library.

Check your answers on page 110 of the Appendix.

You have used the term *population* in reference to cities, countries, and the world many times before. What is a population? Turn to page 256 of the textbook and read "Changing Populations."

4. How is the human population of a town, city, or country defined?

5. How do ecologists define population?

6. What three things do you need to know to identify a population?

7. How can you find out how healthy a population is?

Check your answers on page 110 of the Appendix.

A species in which its population is decreasing quickly is considered to be at risk. In the Starting Point Activity at the beginning of this lesson, you identified some species that are considered to be at risk in Alberta. One of these species is the burrowing owl. In the next activity you will calculate the annual rate of population decrease for the burrowing owl.

Find Out Activity

Population Change

Read the entire activity on pages 256 and 257 of the textbook.

8. In what type of habitat do burrowing owls live?

9. When are burrowing owls active?

10. How many eggs does a female burrowing owl lay?

11. How long does the burrowing owl sit on the eggs before they hatch?

12. Complete the following.

    a. Determine the number of adult burrowing owls in 1979.

    b. Determine the number of adult burrowing owls in 1987.

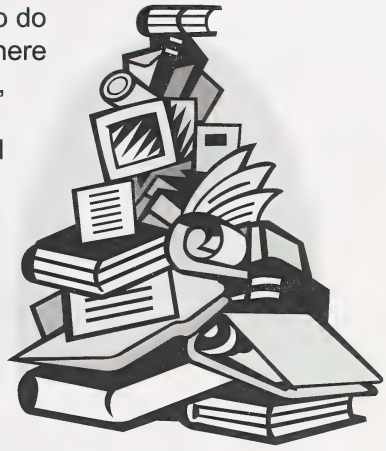
    c. Determine the change in the number of adult burrowing owls from 1979 to 1987. **Note:** Subtract the population in 1979 from the population in 1987.

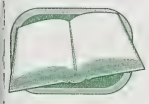
    d. Determine the average annual rate of change in population.

13. Answer questions 1, 2, and 3 of "What Did You Find Out?" on page 257 of the textbook.

Check your answers on pages 110 to 112 of the Appendix.

If you have access to the Internet, you may wish to do "Internet Connect" on page 257 of the textbook. There you will find information on the habitat, distribution, population size and trends, limiting factors, and management policies for the burrowing owl as well as other species currently at risk. You can also find information on burrowing owls in science publications and reference books at your local library.





14. Answer questions 1 to 4 of "Check Your Understanding" on page 257 of the textbook.

Check your answers on pages 112 and 113 of the Appendix.

Go to page 9 of Assignment Booklet 4A and answer questions 1 to 4.

Lesson 2

Population Growth and Decline

Populations change over time. Populations may increase for a while and then decrease. Increases or decreases may be slow, or they may be rapid. What determines how a population changes?

Turn to pages 258 and 259 of the textbook and read the introductory paragraph of "Population Growth and Decline." Then read the information in the white boxes in Figure 13.2.

1. What are the four factors that affect the size of a population?
2. What is birth rate? How does birth rate affect the size of a population?
3. List four factors that affect birth rate.
4. What is death rate? How does death rate affect the size of a population?
5. List three factors that affect death rate.
6. What is immigration? How does immigration affect the size of a population?
7. Why might organisms immigrate to a new area?
8. What is emigration? How does emigration affect the size of a population?
9. Why might organisms emigrate from an area?

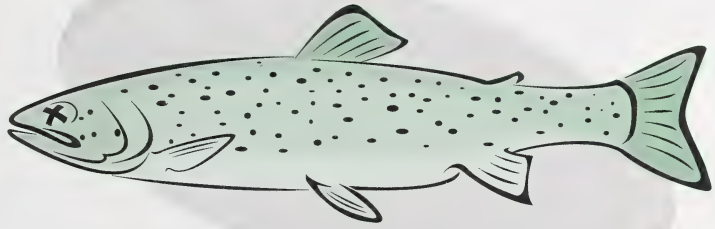
CHECK

Check your answers on pages 113 and 114 of the Appendix.

Turn to page 260 of the textbook and read "Career Connect."

10. Why would most of the fish that enter irrigation canals die?

Check your answer on page 114 of the Appendix.



If you are interested in more information on Trout Unlimited Canada, visit the following Internet site:

http://www.tucanada.org

You have now completed the concepts for this lesson. Do the following questions to review what you covered.

11. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 260 of the textbook.

Check your answer on page 114 of the Appendix.

Go to page 10 of Assignment Booklet 4A and answer questions 5 to 10.

Lesson 3

Limiting Factors

Mosquito larvae need areas of shallow water to develop. When there are many areas of shallow water, the mosquito population can increase quickly. Often, this is to the dismay of the human population in the area. What would happen if the mosquito population continued to increase without control?

In Lesson 2 you identified four factors that determine the size of a certain population at any time. One of the factors, birth rate, increased a population. Another factor, death rate, decreased a population. If the birth rate is higher than the death rate, the size of a poulation will continue to increase. However, in the natural world, most populations cannot increase beyond a certain size. Factors like food supply, water, disease, and space will cause the population to stabilize or decrease. These factors are called **limiting factors**.

Turn to pages 260 and 261 of the textbook and read the introductory information in "Limiting Factors."

1. Define *limiting factors*.

2. List four limiting factors for a population.

3. What do you think is the most important limiting factor for a population of mosquitoes?

4. What is carrying capacity?

5. What affects the carrying capacity of an environment?

6. Which graph on page 260 would be used to show the growth of a mosquito population when conditions are wet?

Check your answers on page 115 of the Appendix.

Limiting factors are divided into two groups: abiotic and biotic. Read the information in "Abiotic Limiting Factors" on page 261 of the textbook.

7. Define *abiotic limiting factors*. List three abiotic limiting factors.

8. Abiotic limiting factors limit the size of a population by decreasing the _____ and increasing the _____ of living organisms.

9. How can matter affect the size of a population?

10. A farmer has a herd of 200 cows and calves that graze on a section (4 quarters) of land. The area has had a drought for the past two years.

    a. Use the idea of abiotic limiting factors to explain how this affects the number of cattle the farmer can graze in the pasture.

    b. What can the farmer do to maintain the cattle population?

Check your answers on page 115 of the Appendix.

Three abiotic limiting factors were described on page 261 of the textbook. Another factor that can affect the growth and development of living things is the pH of the soil or water. The next investigation will show you how pH can affect the germination of seeds.

Investigation

13-A: Abiotic Limiting Factors

Read the entire investigation on pages 262 and 263 of the textbook.

If you have access to a supervised laboratory, do **Part A**. If you do not have access to a supervised laboratory but can obtain the suggested alternate materials, do **Part B**. If you do not have access to a supervised laboratory or the suggested alternate materials, do **Part C.**

Part A

Obtain the required materials and apparatus as listed on page 262 of the textbook. Then follow the procedure carefully to complete the investigation. **Pay careful attention to the safety precautions mentioned.**

11. Write a hypothesis for this investigation.

12. Record your observations in a table like the following.

	Petri Dish 1 (vinegar)	Petri Dish 2 (tap water)	Petri Dish 3 (sodium hydroxide)
pH			
Acid, Base, or Neutral?			
Appearance of Seeds After 1 Day			

Appearance of Seeds After 2 Days			
Appearance of Seeds After 3 Days			
Appearance of Seeds After 4 Days			

13. Answer questions 1 and 2 of "Analyze" on page 263 of the textbook.

14. Explain how this investigation shows that an abiotic factor can limit the size of a population of living organisms.

15. Did the results of this investigation support your hypothesis?

Check your answers on pages 115 and 116 of the Appendix.

Part B

If you are working at home, make the following changes to this investigation.

- Substitute diluted ammonia for the sodium hydroxide. Mix 15 mL of ammonia with 100 mL of tap water.
- Use plates instead of the petri dishes.
- Alfalfa seeds (obtained from a local health food store) can be used in place of chicory seeds.
- Use a spoon in place of a medicine dropper to wet each paper towel. Rinse the spoon after each use.
- You can obtain pH paper at a pet store. (Or you may check the values of pH for vinegar, water, and ammonia in Figure 4.6 on page 65 of the textbook.)

Follow the procedure outlined on page 262 and 263 of the textbook.

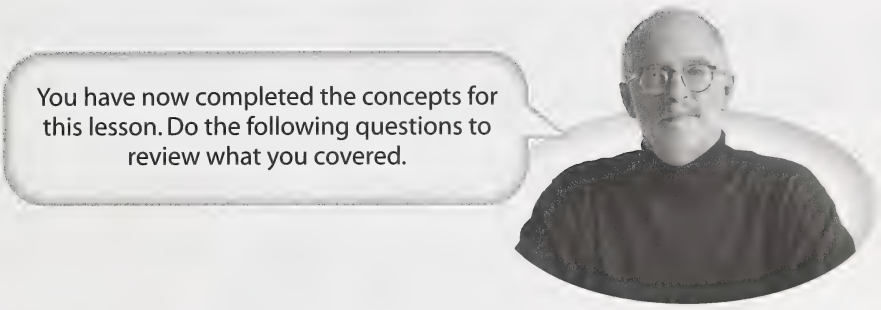
Handle the ammonia carefully and wash your hands and any dish or kitchen utensil used thoroughly after completing the investigation.

Once you have completed the investigation, answer questions 12 to 15 in Part A.
Note: In the table, change the heading Petri Dish 3 (sodium hydroxide) to Dish 3 (ammonia).

Part C

The following results are from a student who performed this investigation. Use this information to answer questions 13, 14, and 15 in Part A.

	Petri Dish 1 (vinegar)	Petri Dish 2 (tap water)	Petri Dish 3 (sodium hydroxide)
pH	3	7	11
Acid, Base, or Neutral?	acid	neutral	base
Appearance of Seeds After 1 Day	Seeds are pale in colour. No seeds germinated.	No change in appearance. One seed germinated.	Seeds are dark in colour. No seeds germinated.
Appearance of Seeds After 2 Days	Seeds are pale in colour. No seeds germinated.	No change in colour. Two seeds germinated.	Seeds are dark in colour. No seeds germinated.
Appearance of Seeds After 3 Days	Seeds are pale in colour. No seeds germinated.	No change in colour. Six seeds germinated.	Seeds are dark in colour. No seeds germinated.
Appearance of Seeds After 4 Days	Seeds are pale in colour. No seeds germinated.	No change in colour. Eight seeds germinated.	Seeds are dark in colour. No seeds germinated.



16. Answer questions 1, 2.a., and 2.b. of "Check Your Understanding" on page 263 of the textbook.

CHECK

Check your answers on page 117 of the Appendix.

Go to ...

Go to page 11 of Assignment Booklet 4A and answer questions 11 to 13.

Lesson 4

Biotic Limiting Factors

A lynx and a coyote share the same forested area. Both animals hunt for food, sometimes for the same food. The number of lynx may affect the coyote population and vice versa. Ways in which interactions among living organisms affect the size of a population are called **biotic limiting factors**.

Turn to page 264 of the textbook and read the introduction to "Biotic Limiting Factors." Then study Figure 13.7 on pages 264 and 265 carefully.

1. List three biotic limiting factors that affect the populations of plants and animals.

2. Define *competition*.

3. Competition occurs among individuals of the same species. Can competition occur among individuals of different species?

4. Define *parasitism*?

5. Name the two types of parasites.

6. How does a parasite affect its host organism?

7. Read "Did You Know?" at the top of page 264 of the textbook. The situation describes parasitism.

   a. Name the host organism.

   b. Name the parasite.

8. Define *predation*.

9. How might the prey population benefit when it is reduced by predation?

10. How do parasites affect the predator-prey relationship?

11. Name two predator-prey relationships from Figure 13.7.

12. Name two individuals of different species that are competing for food in Figure 13.7.

Check your answers on pages 117 and 118 of the Appendix.

Populations of organisms often increase and decrease in size. These fluctuations follow a regular pattern, and a relationship between increases and decreases of both predator and prey populations can be seen. In the next activity you will see this predator-prey relationship between two particular species.

Find Out Activity

Predator-Prey Interactions

Turn to page 266 of the textbook and read the entire activity.

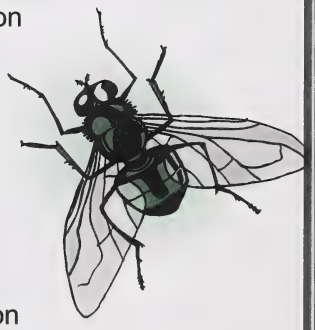
The graph shows the number of lynx and snowshoe hares harvested from 1845 to 1935. The actual population of each species would have a similar pattern.

13. Use the graph to answer questions 1.a., 1.b., 1.c., 1.d., 2, and 3 of "What Did You Discover?"

CHECK Check your answers on page 118 of the Appendix.

Another factor that affects the number of individuals in a population is **reproductive rate**. Some species have high reproductive rates, while other species have low reproductive rates. Generally, species that have high reproductive rates also have high death rates and a large number of predators.

Turn to page 267 of the textbook and read the information in "Reproductive Rate."



14. Why is Earth not overrun with houseflies even though their reproductive rate is so large?

15. What do species that have low reproductive rates do to ensure the survival rate of the species?

16. Answer question 1 of "Check Your Understanding" on page 267 of the textbook.

CHECK Check your answers on page 118 of the Appendix.

Go to ... Go to pages 11 and 12 of Assignment Booklet 4A and answer questions 14 to 19.

Lesson 5

Human Impact

Exotic species are organisms that have been introduced from one area to an area where they have never existed before. Recently, fish farms have accidentally introduced Atlantic salmon into the waters off the coast of British Columbia. It is thought that the Atlantic salmon may out compete other species of salmon that are native to British Columbian waters. This is an example of how humans can impact an ecological region.

Over the years, humans have introduced a number of exotic species to Canada. For information on exotic species, read the information in "Human Impact" on page 268 of the textbook.

1. Name at least three exotic species that have been introduced to Canada.

2. How can an exotic species do ecological damage to the environment?

3. Why do salmon farmers in the Pacific Ocean want to continue to raise Atlantic salmon?

4. Why are scientists worried about Atlantic salmon escaping into the natural environment?

CHECK Check your answers on page 119 of the Appendix.

You may wish to do "Internet Connect" on page 268 of the textbook for more information on exotic species. You can also enter the words *invasive plants* into one of the Internet's search engines. You will get a number of sites on the work of Canadian agriculturists with invasive plants.

5. What are invasive plants?

6. Could you call the purple loosestrife an invasive plant?

CHECK Check your answers on page 119 of the Appendix.

Find Out Activity

Human Impact—Exotic Species

Turn to page 269 of the textbook and read the entire activity. In this activity you are to make a one-page pamphlet describing exotic species.

7. Complete question 1 of "What To Do" on page 269.

CHECK Check your answer on page 120 of the Appendix.

The mosquito is one pest that humans have combatted for decades. In addition to spray programs, some areas have had their wetlands drained to control the mosquito population. To learn about ways in which humans have tried to control mosquito populations, insert the *Science.Connect 1 Student Multimedia* CD into your computer. Launch the applet *Mosquitoes* from the Mosquitoes folder. Follow the instructions in the applet; then answer the following questions.

8. In the food web, which organisms depend directly on the mosquito for food? Which organisms depend indirectly on the mosquito for food?

9. What is a natural method of controlling mosquitoes?

10. When chemical sprays are used to control the mosquito population, what happens to the dragonfly and frog populations?

11. What happens to the fish and frog population when mosquito-breeding habitats are destroyed? Why?

12. How long can mosquito eggs lay dormant, waiting for ideal hatching conditions?

13. In terms of the food web, why is it not good to try to eliminate the mosquito population?

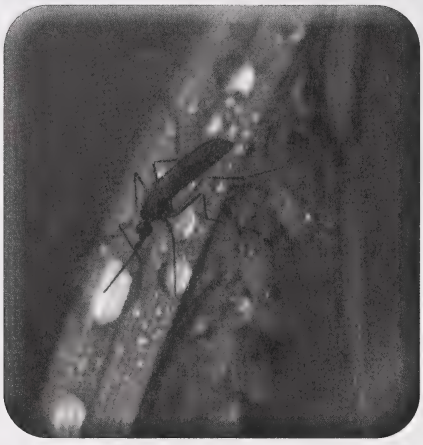
14. Answer question 1 of "Check Your Understanding" on page 269 of the textbook.

Check your answers on pages 120 and 121 of the Appendix.

Go to page 13 of Assignment Booklet 4A and answer questions 20 and 21.

Section 2 Review

In this section you described how birth rate, death rate, immigration, and emigration determined the size of a population. You then discovered that most environments have a carrying capacity for each population. You studied how abiotic and biotic factors limit the size of a population and that other factors—such as competition, predation, and parasitism—control the size of a population. You also examined how human activities can affect the populations of other living things.



You saw how controlling the mosquito population can affect many other organisms. There are other organisms that humans think are pests. Should humans be able to eliminate any organism they view as a pest?

You have now completed the concepts for this section. To review what you covered, answer the following "Chapter 13 Review" questions on pages 270 and 271 of the textbook. If necessary, go back and read over the parts of this section as you answer the questions.

1. Answer questions 2.d., 2.e., 4, and 5 of "Understanding Key Ideas."

2. Answer question 9 of "Problem Solving/Applying."

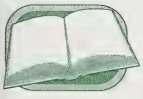
CHECK Check your answers on pages 121 and 122 of the Appendix.

Section 3

ECOSYSTEMS AND BIOMES

Before Europeans came to Alberta, much of the province looked similar to the photographs above. The land was not cultivated; plants, animals, and humans lived in harmony, leaving very little evidence of their existence.

In this section you will learn about Alberta's original ecosystems—the grasslands and the forests with all the plants and animals that lived in these areas. You will describe how abiotic factors determine an area's biotic community. You will identify which factors determine the climate of a region and how climate and vegetation produce large areas of similar ecosystems, called biomes. You will discover the diversity of life in the grasslands and northern boreal forest biomes of Alberta. You will discover that even though extinction has been a natural event, many extinctions today occur due to human activities.



Turn to page 273 of the textbook and read "What You Will Learn," "Why It Is Important," and "Skills You Will Use" for further information of what is expected in this section.

Lesson 1

Ecosystems

If you have gone camping or hiking, you have seen areas of forests and lakes with a large variety of organisms living together. The living organisms and the non-living factors of an environment make up an ecosystem.

Today, many of the ecosystems that were evident before the turn of the century are no longer in existence. To compare the changes in the ecosystem that have occurred over the years and to speculate on what may happen in the future, do the following activity.

Starting Point Activity

Yesterday, Today, and Tomorrow

Turn to page 273 of the textbook and read the entire activity.

1. Answer questions 1 to 4 of "What Did You Discover?"

CHECK Check your answers on page 122 of the Appendix.

What kind of area do you live in? If you live in a city or town, you have the walls and floors of your house or apartment surrounding you. You may also have a yard with some grass and a cement driveway and sidewalk. The street may be made of asphalt or gravel. You may have parents, brothers and sisters, as well as a pet or two. Your environment is made up of all the living and non-living things that surround you. All the living and non-living factors in any environment is called an ecosystem.

Turn to page 274 of the textbook and read the introduction to "Ecosystems." Continue by reading "How Large Are Ecosystems?"

2. What makes up an ecosystem?

3. What are the living components of an ecosystem called?

4. What are the non-living components of an ecosystem called?

5. Does an ecosystem have to be a particular size?

6. Give one example of a small ecosystem and one example of a large ecosystem.

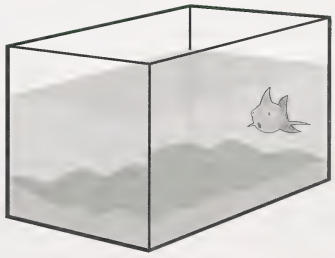
7. Name the three conditions for ecosystems.

CHECK Check your answers on pages 122 and 123 of the Appendix.

Find Out Activity

Build an Ecosystem

Do you have an aquarium with fish in it? If so, then you have set up an ecosystem.



Turn to page 275 of the textbook and read the entire activity. In this activity you will build a small ecosystem.

Follow the procedure carefully. **Pay attention to the safety precautions mentioned. Also, do not try to cut the plastic pop bottle with a utility knife. The knife blade will stick to the plastic and may slip when additional force is exerted.**

8. Record your observations of your model terrestrial ecosystem every day for about two weeks.

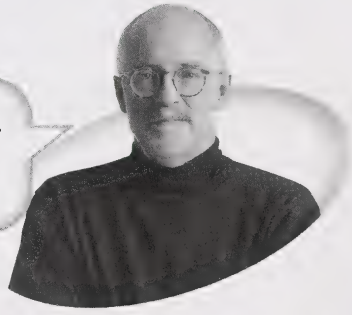
9. What are the abiotic factors in your ecosystem?

10. What are the biotic factors in your ecosystem?

11. How is your model of a terrestrial ecosystem similar to an actual ecosystem?

Check your answers on page 123 of the Appendix.

You now know a little more about ecosystems. Answer the following questions to review what you studied.



12. Answer questions 1 and 2 of "Check Your Understanding" on page 275 of the textbook.

Check your answers on pages 123 and 124 of the Appendix.

Go to pages 1 and 2 of Assignment Booklet 4B and answer questions 1 to 4.

Lesson 2

Climate and Land Ecosystems

Did you know that the temperature at the top of a high mountain is below freezing all year? Why does one area have four distinct seasons while another area has a rainy and a dry season? Different areas on Earth have different climates.

Weather is something Canadians often talk about. This is because weather is changing almost every day in Canada. What is climate and how is it related to weather?

Turn to page 276 of the textbook and read the information in "Climate and Land Ecosystems."

1. Define the terms *weather* and *climate*.

2. What are two conditions of climate?

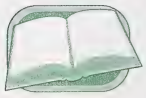
3. What is the difference between climate and weather?

4. Why is climate important?

5. Why don't polar bears live in tropical regions?

6. How do mountains influence climate? Explain and give an example of an area that has climate influenced by mountains.

Check your answers on pages 124 and 125 of the Appendix.

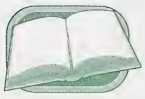


Study the map of Alberta in Figure 14.2 on page 276 of the textbook, and read the captions surrounding it.

7. List the three factors that influence the climate of any region. Briefly describe how each factor affects climate in a region?

Check your answer on page 125 of the Appendix.

Location and Climate



Turn to page 277 of the textbook and read the entire activity. In this activity you will graph the average monthly temperature and the average monthly precipitation for three regions of Alberta. Make sure you give each graph a title and label each axis.

Use the following data to complete this activity.

BANFF (51°N)

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	–10	–5	–2	+3	+8	+12	+15	+14	+9	+5	–4	–9
Precip. (mm)	31	24	22	32	58	60	51	51	44	30	30	34

FORT CHIPEWYAN (58°N)

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	–24	–19	–12	–1	+8	+14	+16	+14	+8	+1	–11	–20
Precip. (mm)	20	14	18	20	30	46	63	47	39	33	28	23

MANYBERRIES (49°N)

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	–11	–8	–2	+5	+11	+16	+19	+18	+12	+6	–3	–9
Precip. (mm)	24	18	23	31	48	57	32	34	31	13	15	23

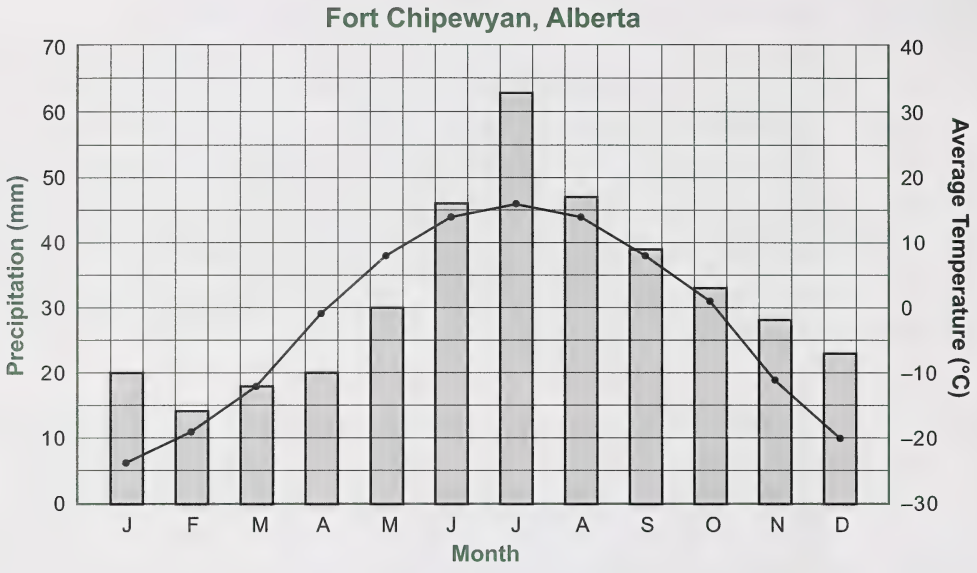
8. Answer questions 1, 2, and 3 of "What to Do."

9. Answer questions 1, 2, and 3 of "What Did You Discover?"

Check your answers on pages 125 to 129 of the Appendix.

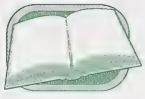
You can also combine the line graph for temperature and the bar graph for precipitation for each location on one graph. Such a graph is called a climatograph. A climatograph has a scale for precipitation on the left and another scale for temperature on the right.

The following is a climatograph for Fort Chipewyan.



10. Make a climatograph for Manyberries.

Check your answer on page 129 of the Appendix.



Read "Did You Know" on page 276 of the textbook. This is an average temperature drop that can be used to predict an approximate temperature at a given elevation. Use the information to answer question 11.

11. The top of a mountain is 4000 m above the base where the temperature is 15°C. Calculate the predicted temperature at the top of the mountain.

12. Answer questions 1 and 2 of "Check Your Understanding" on page 277 of the textbook.

Check your answers on pages 129 and 130 of the Appendix.

Go to pages 2 and 3 of Assignment Booklet 4B and answer questions 5 to 9.

Lesson 3

Location and Soil

Some soils produce good crops; others are more suited for cattle to graze or for a forest to grow. What determines what is good soil? What kind of soil does it take to produce a crop like the one in the photograph?

Soils vary with location, altitude, and topography. Turn to page 278 of the textbook and read the introductory paragraphs of "Location and Soil." Refer to Figure 14.4 at the bottom of the page.

1. Define *soil*.

2. What types of particles make up soil?

3. What does soil provide for plants?

4. How might animals be affected by the type of soil?

CHECK Check your answers on page 130 of the Appendix.

In addition to rock particles of different sizes, good soil contains humus and nutrients. To learn more about the value of humus in soil, read "Humus in Soil" on page 278 of the textbook.

5. What is humus?

6. What are soil crumbs?

7. Why are soil crumbs good for plants?

8. What is leaching?

9. What happens to humus after a period time?

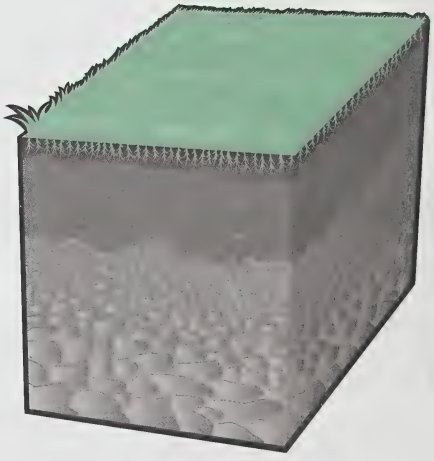
10. How do you think humus is maintained in soil?

Check your answers on page 130 of the Appendix.

Investigation

14-A: Comparing Soils

Soil consists of several layers. The thickness of the upper layers varies with the type of soil. Turn to page 279 of the textbook and read "Think About It."



11. How many layers are there in most types of soil? State the name for each of these layers.

Check your answer on page 130 of the Appendix.

Follow the instructions in "What to Do."

12. Copy and complete a table like the following. Use the information from the diagrams and surrounding descriptions to complete the table.

Soil Location	Relative Thickness of Horizon		General Description of Location	Precipitation Estimate	Role of Decomposers
	A	B			
grassland					
forest					
desert					

13. Which area has the thickest layer of Horizon A?

14. Which area has the most precipitation?

15. Why is the layer of topsoil thicker in the grassland soil than in the forest soil?

16. Which type of soil would be best for growing grain? Why?

Check your answers on page 131 of the Appendix.

If you have access to the Internet, you may wish to complete "Internet Connect" on page 279 of the textbook. Compare the topsoil of a rainforest to the topsoil of an Alberta forest.

Find Out
Activity

Soil

Soils may look fairly simple; but, in actuality, they contain many different types and sizes of particles. In this activity you will put some soil into a jar with water, shake the jar, then allow the contents to settle. You will also inspect the different particles in a dry sample of the soil.

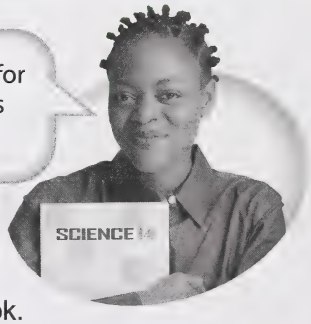
Turn to page 280 of the textbook and read the entire activity.

Now, follow the instruction in "What to Do." If you do not have access to a magnifying glass or dissecting scope, inspect the soil with the naked eye.

17. Answer questions 1 to 4 of "What Did You Discover?"

CHECK Check your answers on page 132 of the Appendix.

You have now completed the concepts for this lesson. Do the following questions to review what you studied.



18. Answer questions 1 and 3 of "Check Your Understanding" on page 280 of the textbook.

CHECK Check your answers on pages 132 and 133 of the Appendix.

Go to ... Go to pages 3 and 4 of Assignment Booklet 4B and answer questions 10 to 13.

Lesson 4

Biomes

Temperatures and precipitation influence the types of plants and animals in a region. Plants and animals are distinct within a particular geographic region. The foothills and mountains in the photograph form a particular geographic region, called a **biome**.

Turn to page 281 of the textbook and read the introductory paragraphs of "Biomes." Study the four biomes shown on the map of Alberta in Figure 14.5.

1. What is a biome?

2. Name the four biomes of Alberta.

3. How would you recognize if you were moving from the parkland biome to the boreal forest biome?

4. What feature makes the mountain and foothill biome distinct?

5. Which two biomes are used mainly for farming today?

CHECK Check your answers on page 133 of the Appendix.

The boreal forest region of northern Alberta is actually part of a large biome called the northern boreal forest biome. This biome covers northern Canada, northern Europe, and northern Asia.

Turn to page 282 of the textbook and read "The Northern Boreal Forest Biome." Study Figure 14.6 on pages 282 and 283 carefully. Make sure you read the individual captions to learn about the different plants and animals that are part of the northern boreal forest biome.

6. What is the climate like in the northern boreal forest biome?
7. How does the climate affect the soil conditions?
8. How do animals in this region adapt to cold weather?
9. What kind of plants grow in this biome?
10. Are there few or many species of organisms in this area?

Check your answers on page 133 of the Appendix.

Read "Did You Know?" at the bottom of page 283 of the textbook. Is it surprising that the spruce budworm larva can survive the winter?

Another biome that makes up part of Alberta is the grassland biome. You may think there are not as many varieties of plants and animals in a grassland biome because there isn't as much shelter.

Turn to page 284 of the textbook and read the information in "The Grassland Biome." Study Figure 14.7 on pages 284 and 285 carefully. Make sure you read each caption to learn about the different plants and animals in the grassland biome.

11. Why do few trees grow in the grassland biome?
12. What types of animals tend to live in the grassland biome? Why?
13. What other organisms are abundant in the grassland biome?

Check your answers on page 134 of the Appendix.

For information on the biomes of the world, insert the *Science 14 Multimedia* CD into your computer. View the segment "Earth's Biomes." Click on each biome and see the parts of the world that are included in that biome. A link to a video that describes the conditions of the biome will also appear. You can then view a chart that shows average temperatures, humidity, and precipitation in the biome.

14. Complete a chart like the following to compare the northern boreal forest biome to the grassland biome.

Biome	Climate	Plant Life	Animal Life
grassland			
northern boreal forest			

15. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 285 of the textbook.

CHECK Check your answers on pages 134 and 135 of the Appendix.

Go to ... Go to pages 4 and 5 of Assignment Booklet 4B and answer questions 14 to 17.

Lesson 5

What Threatens Biodiversity?

Hundreds of years ago most regions in North America had a large biodiversity. Many species of plants, animals, insects, and birds were present in many areas. Today, many of the areas that these organisms lived in have been destroyed or changed by humans.

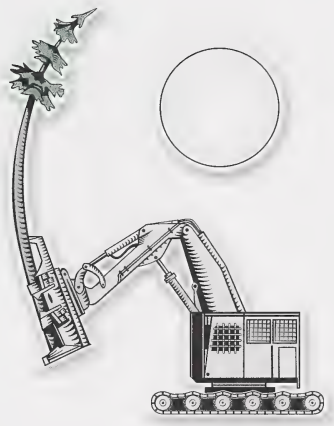
Although humans are having an impact on the biodiversity of life on Earth, other factors have been involved in the threat to biodiversity. Turn to page 286 of the textbook and read the introduction to "What Threatens Biodiversity?"

1. What is extinction?

2. Is extinction something that is brought on only by humans?

CHECK Check your answers on page 135 of the Appendix.

Natural events have caused the extinction of some species during the history of life on Earth. However, human activities in the last 100 years have greatly increased the number of organisms that are on the edge of extinction.



Turn to page 286 of the textbook and read "Human Impact on Biodiversity."

3. What is the main reason for the increased rate of extinction over the past 100 years?

4. Name four ways in which humans have affected the habitats of other organisms.

5. What is meant by *species at risk*?

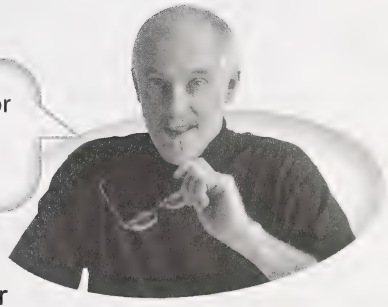
6. Name two species that are at risk.

7. Which species was made extinct at the start of the last century?

CHECK Check your answers on page 135 of the Appendix.

If you have access to the Internet, research species at risk in Alberta using any of the Internet's search engines. You may also try finding information at your local library.

You have now completed the concepts for this lesson. Do the following questions to review what you covered.



8. Answer questions 1 and 3 of "Check Your Understanding" on page 287 of the textbook.

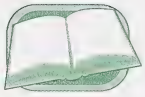
CHECK Check your answers on pages 135 and 136 of the Appendix.

Go to ... Go to page 5 of Assignment Booklet 4B and answer questions 18 to 20.

Section 3 Review

In this section you learned about Alberta's original ecosystems—the grasslands and the forests with all the plants and animals that lived in these areas. You described how abiotic factors determined an area's biotic community. You identified which factors determine the climate of a region and how climate and vegetation produce large areas of similar ecosystems, called biomes. You analyzed the diversity of life in the grassland and northern boreal forest biomes of Alberta. You discovered that although extinction may be a natural event, human activities in the last 100 years have increased the number of species at risk.

Organisms all need a habitat to live in. When one organism changes the landscape to suit its own needs, it affects the habitats of other organisms. The changes made by humans in the last 100 years have significantly impacted other species that co-exist with humans. How has the area you live in affected the habitat of organisms that live there or that may have lived there earlier?

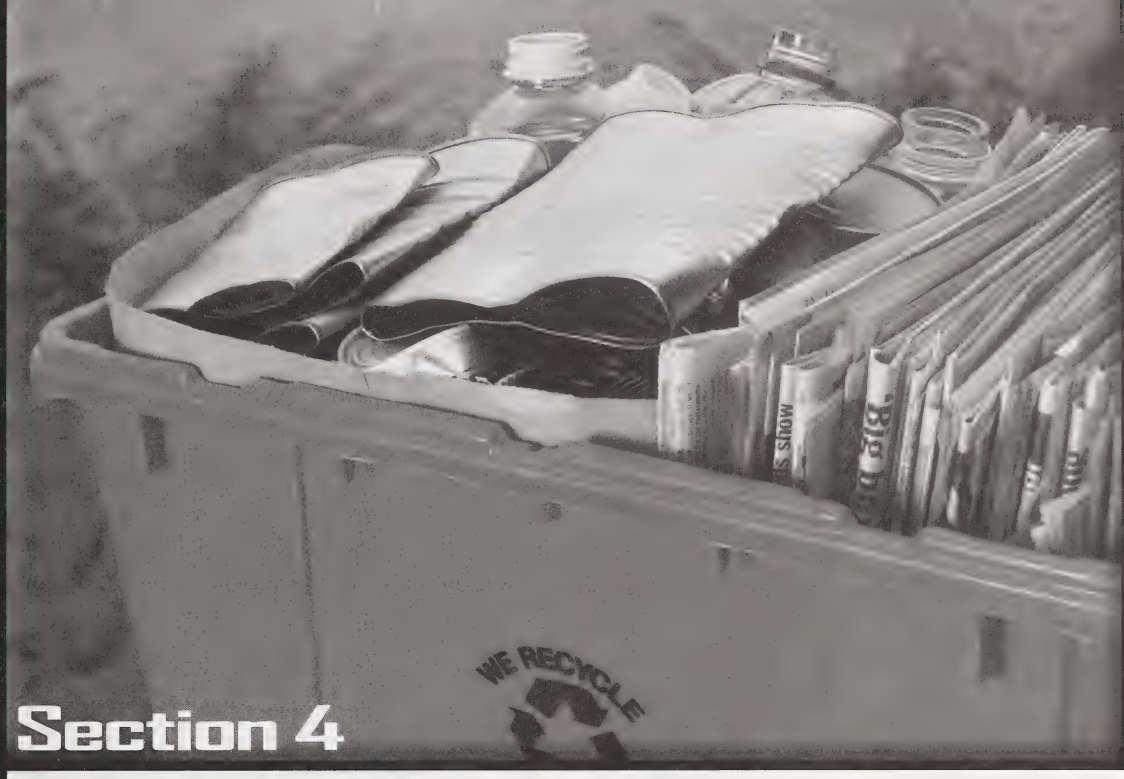


You have now completed the concepts for this section. To review what you studied, answer the following "Chapter 14 Review" questions on pages 288 and 289 of the textbook. If necessary, go back and read over the parts of this section as you answer the questions.

1. Answer question 1 of "Reviewing Key Terms."

2. Answer question 2.b., 2.c., 2.f., 5.a., 5.b., 5.e., 6.a., and 9 of "Understanding Key Ideas."

Check your answers on pages 136 and 137 of the Appendix.



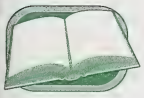
Section 4

PROTECTING THE ENVIRONMENT

In the past, most everything people had as wastes went to the landfill. With the increasing population, landfills have been filling up quicker and quicker. "Where should the next landfill be located?" This question is often debated amongst a population—nobody wants a landfill in their backyard.

Today, people are doing a lot to reduce the amount of garbage that goes to landfills. The most significant method has been recycling. People, today, are recycling a large number of items. Plastic containers, newspapers, and metal items are just a few items that are recycled or separated at landfills and recycling depots today.

In this section you will identify items that are biodegradable and those that are non-biodegradable. You will analyze how technologies designed to produce more food and energy and those designed to improve human lives have affected the environment. You will then investigate the importance of recycling waste products and analyze how reducing waste reduces the amount of energy we use.



Turn to page 291 of the textbook and read "What You Will Learn," "Why It Is Important," and "Skills You Will Use" for further information of what is expected in this section.

Lesson 1

Producing More Food

Each year many farmers try to grow as much food as they can. They do this by using pesticides and synthetic fertilizers. Pesticides and fertilizers can have a harmful effect on the environment.

Turn to page 292 of the textbook and read the introduction to "Producing More Food." Then read the information under "Pesticides" on pages 292 and 293.

1. Why have farmers turned to technology to try to grow more food?

2. What are pesticides?

3. What are two types of pesticides and for what purpose are each used?

4. Why do farmers and homeowners use pesticides?

CHECK Check your answers on page 137 of the Appendix.

Although pesticides are beneficial, there are negative effects as well. One of the earliest pesticides to cause problems was DDT. Reread the information in Figure 15.1 on page 292 of the textbook.

5. What percent of the world's food supply is estimated to be destroyed by pests?

6. What is DDT?

7. How does DDT get into falcons, hawks, and ospreys?

8. What is biological magnification? How does it work?

Check your answers on page 137 of the Appendix.

Weeds and insects in field crops are the main reason for the use of pesticides. Without pesticides, weeds competing with the crops and insects eating the crops will drastically reduce the yield of the crops.

Reread the information in Figures 15.2 and 15.3 on page 293 of the textbook. It provides information on pests that can drastically reduce the yield of grain crops and potato crops.

9. How do weeds reduce the yields of cereal crops?

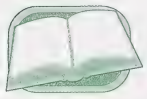
10. What is a side effect of using pesticides?

11. Which insect is a very destructive pest of potatoes?

12. What does it mean when an insect is said to have a natural resistance to an insecticide?

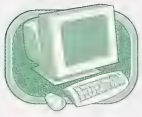
13. What happens with a particular species of insect after a number of years when some individuals have a natural resistance to an insecticide?

14. What do chemical companies do when a particular insect develops a natural resistance to a pesticide?



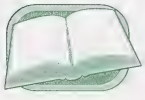
15. Read "Did You Know" on page 293 of the textbook. What is a weed? Are wheat plants growing in a newly planted lawn considered to be weeds?

Check your answers on pages 137 and 138 of the Appendix.



If you have access to the Internet, do "Internet Connect" on page 293 of the textbook. You will find several links to sites on types of pesticides and on the pros and cons of pesticide use.

When farming first began in western Canada, the soil was fertile and produced good crops. Over the years, the nutrients in the soil were depleted and yields went down. To improve yields, synthetic fertilizers were developed. Today, most farmers use a substantial amount of fertilizer to maximize their crop yields.



Turn to page 293 of the textbook and read "Synthetic Fertilizers."

16. Name one plant nutrient in synthetic fertilizers?

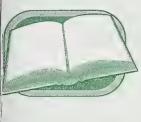
17. What is one potential hazard of increased use of fertilizers? Recall the nitrogen cycle from page 250 of the textbook.

Check your answers on page 138 of the Appendix.

Fertilizers are used to improve plant growth. In the next investigation you will see how fertilizers affect plant growth.

Investigation

15-A: Fertilizers and Plant Growth



Turn to pages 294 and 295 of the textbook and read the entire investigation.

You can obtain pond water from any slough or dugout. Granular fertilizers (such as 51–0–0) or a garden fertilizer (such as 20–9–12–6) are fine. Do not use any type of weed and feed.

> **Note:** The numbers in the fertilizers refer to the relative amounts of nitrogen, phosphorus, potassium, and sulfur. One or more of the elements may not be present in some fertilizers.

If you are working at home, you can measure about 1.25 mL ($\frac{1}{4}$ tsp), 2.5 mL ($\frac{1}{2}$ tsp), 5 mL (1 tsp), and 10 mL (2 tsp) of granular fertilizer. These quantities are equal to approximately 1 g, 3 g, 5 g, and 10 g respectively. If you are using a liquid fertilizer for houseplants, use about half of the amounts given for granular fertilizer. Liquid fertilizers are more concentrated.

Carefully follow the procedure on pages 294 and 295 of the textbook.
Pay special attention to the safety precautions mentioned.

18. Copy and complete a chart like the one on page 295. Remember to adjust the Amount of Fertilizer column to what you used in this investigation.

19. Answer the following on page 295 of the textbook.

    a. questions 1 and 2 of "Analyze"

    b. question 3 to 6 of "Conclude and Apply"

Check your answers on pages 138 and 139 of the Appendix.

You have seen that nitrogen can affect the growth of algae in water quite significantly. The amount of nitrogen in the different parts of the natural nitrogen cycle you studied earlier are balanced. However, when humans add nitrogen through the use of synthetic fertilizers, this balance may be upset.

Turn to page 296 of the textbook and read "How Humans Affect the Nitrogen Cycle." Study the diagram and the statements about **eutrophication** in Figure 15.4 closely.

20. Where do nitrates that have been washed into natural waterways come from?

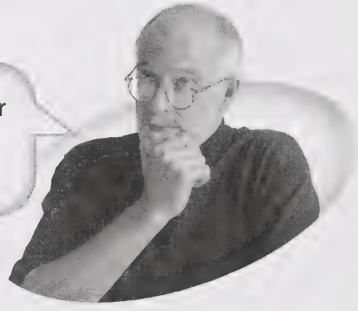
21. What is eutrophication?

22. What starts the process of eutrophication in an aquatic system?

23. How does the introduction of nitrates into a lake eventually kill the fish in the lake?

CHECK Check your answers on pages 139 and 140 of the Appendix.

You have now completed the concepts for this lesson. Review what you covered by answering the following questions.



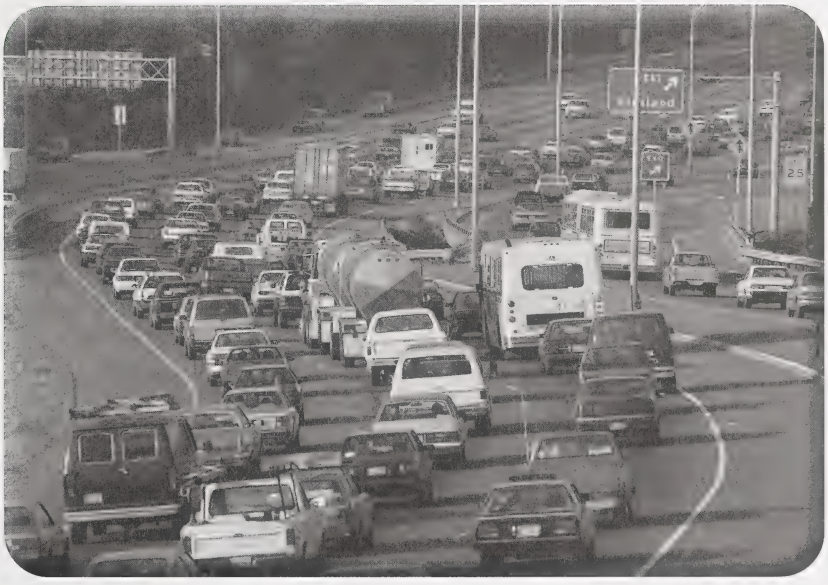
24. Complete textbook questions 1, 2, and 3 of "Check Your Understanding" on page 296 of the textbook.

CHECK Check your answers on page 140 of the Appendix.

Go to ... Go to pages 6 and 7 of Assignment Booklet 4B and answer questions 1 to 5.

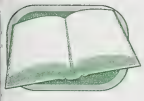
Lesson 2

Producing More Energy



The number of cars and trucks has increased tremendously in North America over the past 10 years. All these vehicles require energy. Homes and businesses also need more energy as people demand warmth in the winter and air conditioning in the summer. Where does all this energy come from? How does this energy consumption affect Earth?

Exploration companies continue to search for and find new sources of energy. It seems like an endless supply. However, since **fossil fuels** are produced over millions of years, they are being used up quicker than they are made. The supply will eventually be exhausted.



Turn to page 297 of the textbook and read the first three paragraphs of "Producing More Energy." Study Figure 15.5 to learn how fossil fuels are formed.

1. What are the three major sources of energy used in Alberta?

2. How were fossil fuels formed?

3. Why was the environment throughout Earth's history considered to be in balance?

4. What product is released into the atmosphere when fossil fuels are burned?

5. How has the burning of fossil fuels affected the balance of carbon dioxide in the atmosphere?

Check your answers on page 140 of the Appendix.

The result of burning fossil fuels is a buildup of carbon dioxide in the atmosphere. Carbon dioxide in the atmosphere provides an insulating blanket around Earth. This is beneficial to a point in that it keeps the Earth from getting too cold. However, it is believed that excessive carbon dioxide in the atmosphere has lead to **global warming**.

Read the information in "Carbon Dioxide and Global Warming" as well as "Did You Know?" on page 297 of the textbook.

6. What is the greenhouse effect?

7. What does the excess carbon dioxide from the burning of fossil fuels do for the greenhouse effect?

8. What is global warming?

9. Three consequences of global warming are given at the bottom of page 297. What would be a possible result of each of these consequences?

10. Is all carbon dioxide in Earth's atmosphere bad? What would happen if there were no carbon dioxide in the atmosphere?

Check your answers on pages 140 and 141 of the Appendix.

Find Out
Activity

The Carbon and Oxygen Cycles and Global Warming

Turn to page 298 of the textbook and read the entire activity. In this activity you will graph data of the amount of $CO_{2(g)}$ released, concentration of $CO_{2(g)}$ in the atmosphere, and average temperature increase for each 20-year period from 1850 to 1990.

11. Answer questions 1 to 4 of "What to Do?" **Note:** Use the data in the following table to answer questions 3 and 4.

Year	$CO_{2(g)}$ Production (billions of tonnes)	$CO_{2(g)}$ Concentration (parts per million)	Average Temperature Increase (°C)
1850	0.01	286	0.00
1870	0.02	292	0.00
1890	0.04	298	0.05
1910	0.09	300	0.13
1930	1.20	305	0.46
1950	1.80	310	0.47
1970	4.10	320	0.53
1990	5.00	340	0.58

12. Answer questions 1 to 4 of "What Do You Think?"

CHECK

Check your answers on pages 141 to 143 of the Appendix.

You have now completed the concepts for this lesson. Do the following questions to review what you studied.

13. Answer questions 1, 2, and 3 of "Check Your Understanding" on page 298 of the textbook.

CHECK Check your answers on pages 143 and 144 of the Appendix.

Go to ... Go to pages 7 and 8 of Assignment Booklet 4B and answer questions 6 to 10.

Lesson 3

Producing More Products

In today's society, there are many items that make life more convenient and safer. Take a look in your kitchen, for instance. There are many items there that make your life easier. One of these items is the refrigerator. The refrigerator makes it convenient and safe to store food. However, scientists have found that there are problems associated with refrigerators.

Turn to page 299 of the textbook and read the introduction to "Producing More Products" and the information in "The Refrigerator."

1. How did people preserve foods before the refrigerator came into common use?

2. What problems did these methods of food preservation have?

3. What is the fluid used to remove heat in a refrigerator called?

4. a. What type of chemicals have been used as a refrigerant in the past?

   b. Why were these chemicals used as a refrigerant?

   c. What problem did these chemicals create in the atmosphere?

Check your answers on page 144 of the Appendix.

Investigation

15-B: Refrigeration Has a Down Side

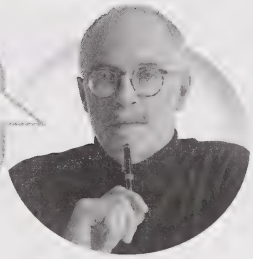
The major use of CFCs was in refrigeration and air conditioning. Other uses of CFCs include solvents to clean electronic components and blowing agents in the production of plastic foams. In 1991 the Montreal Protocol created rules for banning the use of CFCs. As a result, extensive research to replace CFCs has been done. Replacements for CFCs include HCFCs (hydrochlorofluorocarbons), HFCs (hydrofluorocarbons), and PFCs (perfluorocarbons).

Turn to page 300 of the textbook and read the entire investigation. You will discover how scientists found out how CFCs affected the ozone layer.

5. Answer questions 1 to 5 of "Analyze." **Note:** You will need to use the information on pages 299 and 301 to answer these questions.

Check your answers on pages 144 and 145 of the Appendix.

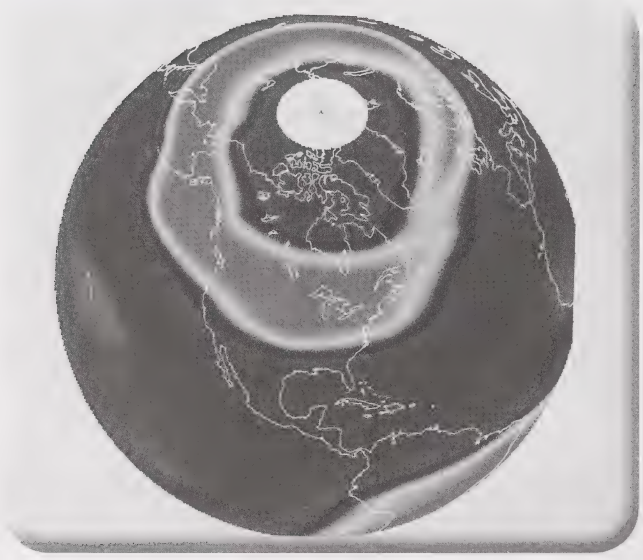
You have now completed the concepts for this lesson. Do the following question to review what you covered.



6. Answer question 4 of "Check Your Understanding" on page 301 of the textbook. You may need to use the Internet or your local library to look for information to answer this question.

Check your answer on page 145 of the Appendix.

For more information on ozone and refrigeration, do "Internet Connect" on page 300 of the textbook. You will find information on the history of refrigeration as well as a site that provides information on ozone depletion and substances that harm the ozone layer.



Go to pages 8 and 9 of Assignment Booklet 4B and answer questions 11 to 14.

Lesson 4

Why So Much Waste?

How much garbage does your family produce? We all produce garbage. According to statistics, every Canadian produces about 2.2 kg of garbage every day. How can you reduce the amount of garbage you produce?

In Module 1 you learned about using concentrated solutions to reduce waste by reducing packaging. In this lesson you will investigate other ways of reducing the amount of garbage you produce.

1. Make a list of items you throw away every day.

Check your answer on page 145 of the Appendix.

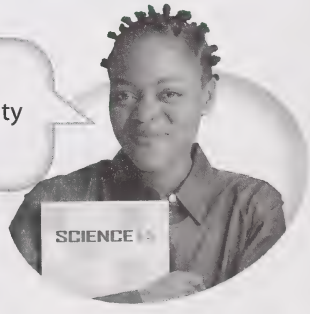
In cities and towns, most residents have their garbage picked up from their homes. What happens to your garbage after it is picked up? Most of it goes to a landfill nearby. If you live on a farm or acreage, you most likely have to haul your own garbage to a landfill or transfer station. Modern landfills are no longer open pits in the ground. Modern landfills have heavy plastic liners and cover garbage with a layer of soil each day. Seepage is pumped out, and test holes around the site are examined to make sure there is no leakage through the liners.

Turn to page 302 of the textbook and study Figure 15.11. The diagram is of a completed landfill cell.

2. What is a landfill?

3. Why are landfills lined with plastic on the sides and bottom?

CHECK Check your answers on page 146 of the Appendix.


Materials that go into landfills fall into two groups: biodegradable and non-biodegradable. The next activity will give you more insight on these two groups.

Starting Point
Activity

Biodegradable vs. Non-Biodegradable Materials

Turn to page 291 of the textbook and read the entire activity.

Use the following table as a guideline to classify the items. If you are working at home, check the items that are in your garbage can on a particular day. Decide whether the items are biodegradable or non-biodegradable.

Items	Time to Break Down
paper towel, newspaper, cardboard, waxed milk carton	up to 3 months
cotton glove, cotton rope, wool glove, some beverage containers, biodegradable diaper	up to 1 year
plywood, painted wood	up to 15 years
Styrofoam® cup, tin can	up to 100 years
aluminum can, disposable diaper, plastic drinking bottle, fishing line	up to 600 years
glass	undetermined

4. Answer questions 1, 2, and 3 of "What Did You Discover?"

CHECK

Check your answers on page 146 of the Appendix.

Find Out
Activity

Saving Energy

Turn to page 302 of the textbook and read the entire activity. You will calculate how long you can keep your television going if you recycle pop cans. **Note:** If you are working alone, assume there are 30 students in a classroom.

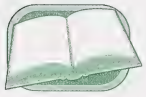
5. Answer the following.

   a. question 1 of "What to Do"

   b. questions 1 and 2 of "What Did You Discover?"

Check your answers on pages 146 and 147 of the Appendix.

Canadians and North Americans, in general, throw away a lot because of their standard of living. Even large items, like televisions and refrigerators, have become inexpensive enough to buy that they are not worth fixing when they break down. The result is they end up in the landfill.



Turn to page 303 of the textbook and read "Garbage Delight." Also, study Figures 15.12, 15.13, and 15.14.

6. Why do Canadians throw away so much waste?

7. How much packaging from fast foods ends up in the garbage?

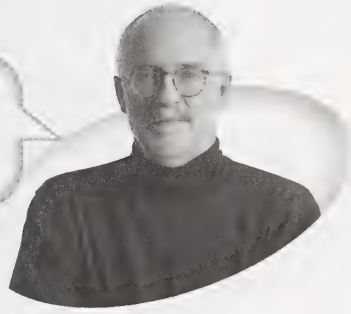
8. Describe three ways to reduce garbage.

9. What items are recycled in your community?

Check your answers on page 147 of the Appendix.

Most items are difficult to recycle. This is often because of the number of different components in the product. An item like a computer monitor or a television set is difficult to recycle because of the number of different parts. One of the easiest items to recycle is an aluminum can.

If you have access to the Internet, do "Internet Connect" on page 303 of the textbook. You will find information on how aluminum is produced from bauxite and how aluminum cans are recycled.



10. Answer questions 1 and 3 of "Check Your Understanding" on page 303 of the textbook.

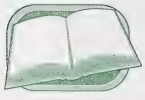
CHECK Check your answers on page 148 of the Appendix.

Go to ... Go to page 9 of Assignment Booklet 4B and answer questions 15 to 17.

Lesson 5

What Can We Do?

Hundreds of years ago there were many areas like the one in the photograph in Alberta. Over the years land has been logged, cleared, and drained. This has greatly reduced the number of wetlands and has forced wildlife to move to other locations or die out. Efforts are now being made to restore many areas.



Turn to page 304 of the textbook and read the introduction to "What Can We Do?" You will read about someone who is trying to restore some areas in Alberta to their natural state—the way they were before humans altered them. Study Figures 15.15, 15.16, 15.17, 15.18, and 15.19 on pages 304 and 305 carefully.

1. Who is David Matheson?

2. What are wetlands?

3. What are three benefits of wetlands?

4. How can wetlands be restored?

5. Name the four ways David Matheson says you can help wildlife.

6. How did David Matheson and a group of volunteers help ducks and great blue herons in the Grande Prairie region?

Check your answers on pages 148 and 149 of the Appendix.

Read "Try This!" on page 305 of the textbook. If you can obtain some peat, try this activity.

7. Why do gardeners add peat to their soil?

Check your answer on page 149 of the Appendix.

Ducks Unlimited Canada is a private, non-profit organization that is dedicated to restoring and maintaining wetlands in Canada. If you have access to the Internet, do "Internet Connect" on page 305 of the textbook. You will find out more about Ducks Unlimited and how you can get involved.

8. Name at least one career opportunity available through Ducks Unlimited.

9. Answer question 2 of "Check Your Understanding" on page 305 of the textbook.

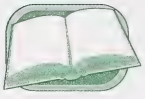
Check your answers on page 149 of the Appendix.

Go to page 10 of Assignment Booklet 4B and answer questions 18 and 19.

Section 4 Review

In this section you analyzed how technologies designed to produce more food and energy and those designed to improve human lives have affected the environment. You investigated the importance of recycling waste products, and you identified items that are biodegradable and those that are non-biodegradable. You then examined how reducing waste reduces the amount of energy we use. Finally, you observed how some people are trying to restore some habitats to the way they were originally.

To reduce the amount of garbage that goes into landfills, people need to reduce what they throw away and re-use and recycle as much as possible. Are you doing your part to help reduce wastes that go into the environment?



You have now completed the concepts for this section. To review what you studied, answer the following "Chapter 15 Review" questions on pages 306 and 307 of the textbook. If necessary, go back and read over the parts of this section as you answer the questions.

1. Answer question 1 of "Reviewing Key Terms."
2. Answer question 4 of "Understanding Key Ideas."
3. Answer question 8 of "Developing Skills."
4. Answer question 9 of "Problem Solving/Applying."

Check your answers on pages 149 to 151 of the Appendix.

Module Summary

In this module you discovered how matter and energy flow throughout the biosphere. You identified changes that have occurred in the last 100 years due to human impact and analyzed environmental problems that have occurred as a result.

In Section 1 you discovered how energy from the Sun is captured by plants and converted into chemical energy. You described how chemical energy is converted into mechanical energy and heat energy as it passes through the food web. You learned that matter cycles over and over again between plants and animals and between the atmosphere and the earth.

In Section 2 you studied how organisms interact with their own population, with other populations, and with the abiotic environment. You identified abiotic and biotic factors and learned how these factors affect the size of a population. You also identified environmental problems that have been created by humans and analyzed how the populations of other living things have been affected.

In Section 3 you analyzed the abiotic and biotic factors and determined how these factors work to produce large areas of similar ecosystems, called biomes. You observed that extinction of a species may be a natural event and that human activities have contributed to in the extinction of some species.

In Section 4 you identified technologies designed to produce more food and energy and improve human lives. You observed that these technologies have also affected the environment. You described ways of reducing waste and showed that reducing waste can reduce the amount of energy used.

Ways of reducing consumption and waste production requires the aid of all humans on the planet. Are you ready to do your part?

APPENDIX ■

GLOSSARY ■ SUGGESTED ANSWERS ■ IMAGE CREDITS

Glossary

altitude: the height of a location above sea level

biotic limiting factor: a way in which interactions among organisms might affect the size of a population

biological control: any organism that is used to control the numbers of another organism

biological magnification: the accumulation of chemicals in animals as one moves up the food chain

biome: a large geographic area with distinct plants and animals

biodiversity: large variety of living things in an area

birth rate: the number of individuals born into a population over a period of time (usually 1 year)

carbon and oxygen cycles: the natural cycling of carbon dioxide and oxygen through photosynthesis, cellular respiration, and decomposition

CFC: a class of chemicals that were used as refrigerants in the past but were discontinued as refrigerants because of their harmful effect on the ozone layer

climate: the average weather conditions (temperature and precipitation) in a region over hundreds of years

competition: individuals competing for resources in an area

compost: a mixture of decomposing plants and soil

consumer: an organism that eats producers or other consumers

cycle: the re-use of matter in ecological systems

death rate: the number of individuals of a population that die over a period of time (usually 1 year)

decomposer: an organism that breaks down dead plants and animals, uses the energy, and returns the elements to the environment

denitrification: the removal of nitrogen or nitrogen groups from a compound

ecological pyramid: a model in the shape of a triangle showing the relative numbers of organisms in a food chain

ecosystem: a community of living things and the environment in which they live

emigration: the departure of individuals from a population

energy: the property or quality of a thing that gives it the ability to move, do work, or cause changes

eutrophication: the buildup of nutrients in an aquatic ecosystem that results in increased plant growth and reduced oxygen levels

exotic species: a species that has been introduced to an area from another area

extinction: the elimination of a species from Earth

food chain: a model that shows how energy and matter are passed from one organism to another in an ecosystem

food web: a network of food chains that provides a complete model of how energy and matter are passed from one organism to another

fossil fuel: a fuel formed from the remains of organisms that lived millions of years ago

e.g., coal, natural gas, oil

global warming: a hypothesis stating that excess carbon dioxide in the atmosphere is causing an increase in average global temperatures on Earth

glucose: a basic sugar made by plants during photosynthesis

greenhouse effect: the situation where carbon dioxide and other gases form a blanket around Earth that traps heat and keeps it from escaping into space

habitat: an organism's shelter and food

host: an organism upon which another organism depends

horizon: horizontal layers in soil

humus: part of soil that contains decaying plant fibres and organisms as well as soil

immigration: the arrival of individuals into a population

individual: one member of a population

landfill: a site that has been built to prevent waste materials from entering the environment

latitude: the distance north or south a location is from the equator

leaching: the washing down of materials in the soil by rain water

limiting factor: a factor that limits the growth of a population

nitrogen cycle: the natural cycling of nitrogen through food chains, decomposition, and fixing/producing bacteria

ozone layer: a layer of gas in Earth's atmosphere that absorbs UV radiation from the Sun

The ozone layer is about 15 km to 35 km above Earth's surface.

parasitism: a relationship between two organisms in which one organism benefits and the other is harmed

pesticide: a chemical used to eliminate unwanted plants or animals

predator: an organism that catches and eats other organisms

prey: an animal that is caught and eaten by a predator

predation: a relationship in which one organism catches and eats another organism

primary consumer: a consumer that eats plants

population: a group of individuals of the same species that lives in the same place at the same time

producer: an organism that is able to make its own food

pyramid of energy: a model in the shape of a triangle that shows the relative amount of energy available at each level in a food chain

refrigerant: a substance used in refrigerators and air conditioners that absorbs and transfers heat

reproductive rate: the rate at which offspring are produced by an organism or pair of organisms

secondary consumer: a consumer that eats primary consumers

species at risk: a species that is near extinction

soil crumbs: particles of humus that have formed crumbs

starch: the carbohydrate form in which plants store excess glucose produced during photosynthesis

tertiary consumer: a consumer that eats secondary consumers

topography: the physical features of a region

e.g., mountains, lakes, rivers, and trees

topsoil: the upper most layer of soil

water cycle: the natural cycling of water through evaporation/transpiration, condensation, and precipitation

wetland: a marshy area that remains wet throughout the year

Suggested Answers

Section 1: Lesson 1

1. In the early 1900s energy used by the horses came from the grasses, hay, and grains fed to them. Today, energy for modern tractors comes from diesel fuel refined from crude oil.

2. Features that are different include the following:

    - The street is dirt in 1906 Red Deer and paved in modern Red Deer.
    - Telephone and power poles are gone from modern Red Deer.
    - Buildings are smaller and mostly made of brick in 1906 Red Deer.
    - Modern Red Deer buildings have glass, brick, and tile.
    - Various wild plants grow along the street in 1906 Red Deer.
    - In modern Red Deer, only planted trees are growing.

3. Technologies that people have developed include

    - the presence of cars
    - the use of street lights and steel poles
    - the use of pavement on streets
    - no visible telephone or power lines
    - buildings made of materials other than brick and wood

4. Energy is the property or quality of a thing that gives it the ability to move, do work, or cause changes.

5. Humans get their energy from the food they eat.

6. Humans get their energy in the form of **chemical energy**.

7. Plants get their energy from the Sun in the form of light energy.

8. The substance most organisms use as a source of chemical energy is **glucose**.

9. Chemical energy transforms into thermal (heat) energy and mechanical energy.

10. The equation in Figure 12.1 represents photosynthesis. The equation in Figure 12.2 represents cellular respiration.

11. Your list should include some of the following.

    Photographs A and B on Page 239

    - chemical energy in the grain being fed
    - mechanical energy in throwing grain, in chickens picking up and eating the grain, and in cattle eating the hay (or silage)
    - mechanical energy used to cut the boards and other materials used in the building, hay rack, feedlot fences, etc.
    - mechanical energy of people and animals moving about
    - light energy from the Sun to grow trees for the boards in the building, hay rack, feedlot fences, and feeders
    - heat energy from the Sun
    - sound energy of chickens clucking, children laughing, and cows mooing

Photographs A, B, C, and D on Pages 236 and 237

- chemical energy from the food to give the horses energy to pull the plow
- chemical energy from the diesel fuel used in the tractor
- mechanical energy of the horses moving the plow and the tractor moving the tillage equipment
- mechanical energy to produce the materials used to make the equipment, building materials, cars, pavement, and construction of all equipment
- heat energy from the Sun absorbed in soil
- electrical energy in telephone wires, street lights, building lights, car batteries, etc.
- light energy from the Sun to grow trees and grass

12. The forms of energy include

- light energy from the Sun
- chemical energy
- heat energy
- electrical energy
- mechanical energy
- sound energy

13. **Textbook questions 2 and 3 of "What Did You Find Out?," p. 239**

2. The Sun is the source of energy for all of the living things shown in the pictures.

3. Four ways in which energy is transformed from one type to another are as follows:

- light energy from the Sun to chemical energy
- chemical energy to mechanical energy
- chemical energy to mechanical energy to sound energy
- chemical energy to heat energy

14. **Textbook questions 1 and 3 of "Check Your Understanding," p. 239**

1. a. Energy does not have mass and does not take up space.

b. Energy cannot be created nor destroyed.

c. Energy can be transformed from any one of several forms to any other form.

d. Energy can be transferred from one object to another object.

3. The primary source of energy in the human diet is plants, such as wheat, rice, and corn. Worldwide, this source of energy has not changed much in the last 100 years. However, in North America there is an increased dependence on animal foods, such as meat, milk, and eggs.

Section 1: Lesson 2

1. a. Plants produce glucose and store excess glucose as **starch**.

   b. Your body breaks down starch into **glucose** during digestion.

   c. The chemical energy in glucose is released by the **mitochondria** in your cells.

2. Bread and French fries are two food items that contain starch.

3. You may have said that the starch will be located in the part of the leaf that is exposed to the Sun or that no starch will be located in the covered part of the leaf.

4. a. **Textbook questions 1 and 2 of "Analyze," p. 241**

      1. Yes, starch was present in the leaf.

      2. The leaf formed starch from excess glucose.

   b. **Textbook questions 3, 4, and 5 of "Conclude and Apply," p. 241**

      3. If you hypothesized that the starch was located in the part of the leaf that was exposed to the Sun or that no starch was present in the covered part of the leaf, your hypothesis would have been supported by the results of your investigation.

      4. Iodine is used because it turns black if starch is present. It remains yellow (or orange-red) if no starch is present.

      5. The hot alcohol removes most of the chlorophyll, so the colour change will be noticeable when the iodine is added.

c. **Textbook questions 6 and 7 of "Extend Your Knowledge," p. 241**

6. No. After three days, most of the starch would have been converted back into glucose so the plant can carry on its life activities.

7. You would either cover one leaf completely with dark paper for three days or put the entire plant in the dark for three days. Your investigation to test the answer to question 6 would then use a similar procedure involving iodine and hot alcohol as in this investigation.

5. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 241**

1. Plants get the energy they need to produce glucose (chemical energy) from the Sun.

2. Plants store excess chemical energy in their leaves and roots for later use. They can use the excess energy to survive when there is no sunlight or when their leaves fall off in the winter. Excess chemical energy is also used for growth and reproduction in the spring.

3. The source chemical energy for animals is plants. Some animals eat the plants and obtain energy directly from the plants. Other animals eats animals that got their energy from plants.

Section 1: Lesson 3

1. An ecosystem is a community of living things and the environment in which they live.

2. An ecosystem contains both **living** and **non-living** components.

3. Examples of living components include plants, animals, and bacteria. Examples of non-living components include rocks, weather, and water.

4. A producer in a food chain is an organism that can make its own food.

5. Green plants are the producers in the food chain in Figure 12.3.

6. A consumer is an organism that eats either a producer or another consumer.

7. The grouse and the great horned owl are the two consumers in the food chain in Figure 12.3.

8. The energy in the food chain in Figure 12.3 travels from the producer (green plants) to the first consumer (grouse) to the second consumer (great horned owl).

9. Decomposers break down wastes and the bodies of dead plants and animals.

10. Algae is the producer in the food chain.

11. The insect larvae, perch, northern pike, and human are the consumers in the food chain.

12. The perch directly provides energy to the northern pike. You may say that each organism left of the northern pike in the food chain provides energy for the northern pike.

13. The energy for this food chain originally comes from the Sun. The algae captures the Sun's energy and produces glucose like any other green plant.

14. **Bannock**

    Sun ➡ *bannock (corn), oatmeal, barley meal* ➡ human

    Sun ➡ *grass* ➡ *bison (animal fat)* ➡ human

    Cabbage

    Sun ➡ cabbage ➡ human

    Rabbit

    Sun ➡ grass ➡ rabbit ➡ human

15. **Textbook question 1 of "What Did You Find Out?," p. 243**

    1. The original source of energy for the food chains is the Sun.

16. **Whole-Wheat Bread**

    Sun ➡ wheat ➡ human

    Lettuce

    Sun ➡ lettuce ➡ human

    Fish

    Sun ➡ algae ➡ insects ➡ fish ➡ human

17. The food chains are very similar. They all begin with the Sun and end with humans.

18. A food web is a more complex model (more complete than a food chain) showing how energy moves in an ecosystem.

19. A primary consumer is an organism that eats plants.

20. A secondary consumer is an organism that eats other organisms.

21. A tertiary consumer is an organism that eats organisms that eat other organisms.

22. a. Green plants are the producers.

    b. The primary consumers in the food web are the insect, grouse, mouse, and snowshoe hare.

    c. The secondary consumer in the food web are the bat, shrew, grouse, weasel, and great horned owl.

    d. The tertiary consumer in the food web is the great horned owl. There are no other tertiary consumers in this food web.

23. The food chains within the food web on page 244 of the textbook are as follows:

    green plants ➡ insects ➡ bat ➡ great horned owl
    green plants ➡ insects ➡ shrew ➡ great horned owl
    green plants ➡ insects ➡ grouse ➡ great horned owl
    green plants ➡ insects ➡ grouse ➡ weasel ➡ great horned owl
    green plants ➡ grouse ➡ great horned owl
    green plants ➡ grouse ➡ weasel ➡ great horned owl
    green plants ➡ mouse ➡ great horned owl
    green plants ➡ mouse ➡ weasel ➡ great horned owl
    green plants ➡ snowshoe hare ➡ weasel ➡ great horned owl
    green plants ➡ snowshoe hare ➡ great horned owl

24. **Textbook question 1 of "Check Your Understanding," p. 244**

    1. The correct version of the food chain is as follows:

       seeds ➡ sparrow ➡ hawk

       Seeds are a producer. Producers always start a food chain.

Section 1: Lesson 4

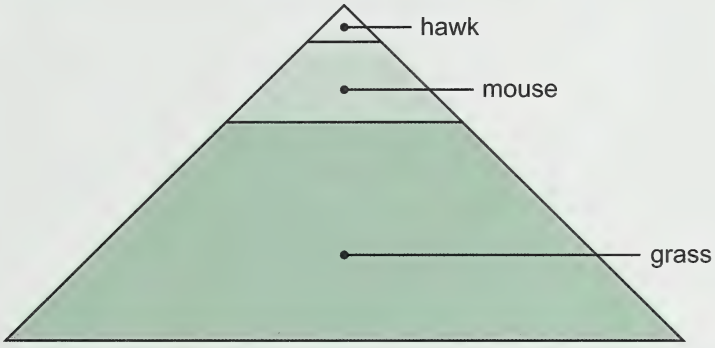
1. The base of the pyramid is made up of native grasses.

2. The top of the pyramid is made up of wolves.

3. There are more bison than wolves.

4. An ecological pyramid shows the relative numbers of organisms at each level. It also shows the amount of energy available at each level.

5. Your pyramid should look similar to the following.



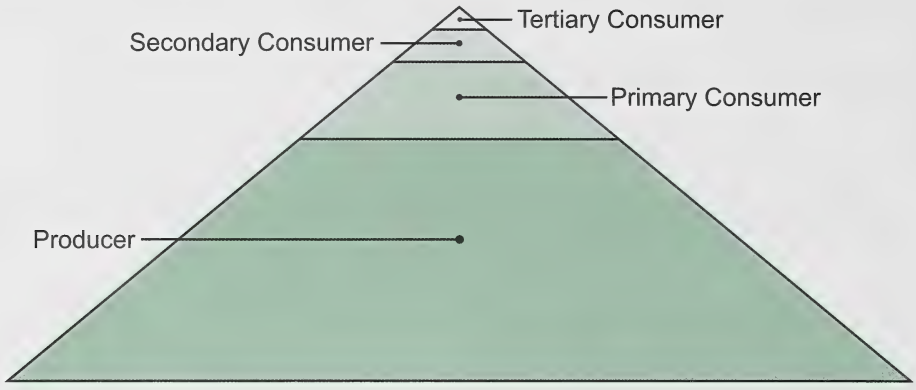
6. No, all the grass in a given natural area is not always eaten.

7. Organisms use energy for their own growth, for reproduction, and for bodily functions (such as digestion and circulation).

8. Some energy remains in the organism when it dies. Decomposers break down the dead organism and use this remaining energy.

9. Organisms lose some energy in the form of heat and wastes every day.

10. Your pyramid should look similar to the following.



11. The sheet of notebook paper corresponds to the bottom layer of the pyramid that contains the most energy. The largest rectangle cut out corresponds to the amount of energy available to the primary consumers. The next rectangle cut out corresponds to the amount of energy available to the secondary consumers. The smallest rectangle corresponds to the top level of the pyramid. It shows the amount of energy available to tertiary consumers.

12. **Textbook questions 1, 2, and 3 of "Analyze," p. 246**

    1. Wheat, oats, corn, grasses, and algae are examples of organisms that would be found at the bottom of the pyramid. These organisms are producers.

    2. Hawks, owls, coyotes, foxes, wolves, bears, lions, and tigers are examples of organisms that could be found at the top of the pyramid. These organisms are consumers.

    3. There are fewer organisms at each higher level because the organisms at each level have to live off the ones below. If only 10% of the energy is passed up to the next level, there have to be fewer organisms to survive.

13. **Textbook questions 4 and 5 of "Extend Your Skills," p. 246**

    4. a. The amount of energy available at the top of the pyramid is much less than the amount of energy available at the bottom.

       b. There is less energy at the top because energy is used for various functions by the organisms at each level.

    5. The organisms at the other levels would die out if you remove the producers. All the upper levels depend on producers to convert the Sun's energy to a usable form of food.

14. **Textbook questions 1, 3, and 4 of "Check Your Understanding," p. 247**

    1. Your food chain should look like the following.

        twigs, leaves, and bark of willows and aspen ➡ moose ➡ wolves

    3. Large carnivores require a large amount of energy to survive. The amount of energy available at each level decreases as you go up a level. If there are too many large carnivores, many would not get enough food and would eventually die out.

    4. a. The most energy would escape as heat in the longest food chain because there are more levels.

        b. The first food chain would provide the maximum amount of energy for humans because there is the least number of levels and, therefore, the least amount of energy lost. There is only one exchange of energy.

Section 1: Lesson 5

1. Animals break down the plant matter they eat. The matter is then recombined to form animal tissues.

2. One way water enters the atmosphere to become precipitation is through evaporation from oceans and lakes. Another way water enters the atmosphere to become precipitation is through transpiration from plants.

3. After it rains on land, three things that happen to the water from the rain are as follows:

    - Some of it is absorbed by plants or drunk by animals.
    - Some of it runs off the surface of the land into streams, lakes, and oceans.
    - Some of it seeps into the soil to become part of the ground water.

4. The Sun is the driving force behind all cycles of matter.

5. Of all available water, only 1% is fresh water.

6. When plants recycle water into the atmosphere, the water is **purified**.

7. Surface runoff is water that flows in streams and rivers to the ocean.

8. Evaporation and transpiration purify water.

9. Evaporation occurs when water is heated by the Sun's energy and changes from a liquid to a gas, which then rises into the atmosphere.

10. Of the water in the atmosphere, 40% is from transpiration.

11. Condensation is the formation of water droplets when water vapour cools.

12. Clouds are composed of millions and millions of droplets of condensed water vapour.

13. Water is constantly recycled between Earth's surface and the atmosphere. So, the water in your drinking glass is the same water from the time of the dinosaur. Water is not created; it is recycled within the system.

14. During photosynthesis, plants use carbon dioxide as one of the components to produce glucose. Oxygen is released to the atmosphere as one of the products during this process.

15. Carbon dioxide is released into the atmosphere during cellular respiration.

16. Decomposition uses **oxygen** and releases **carbon dioxide** into the atmosphere.

17. Carbon dioxide is returned to the atmosphere:

    - through the burning of fossil fuels
    - through the burning of forests
    - through cellular respiration
    - through decomposition of dead organisms

18. The order is as follows:

    (1) In the carbon and oxygen cycles, plants use carbon dioxide from the atmosphere to make glucose through the process of photosynthesis.

    (2) During photosynthesis, plants give off oxygen to the atmosphere.

    (3) During cellular respiration, glucose and oxygen are converted into carbon dioxide, water, and energy.

    (4) The carbon dioxide is released into the atmosphere to be used again by plants to make more glucose.

    (5) Plants and animals die, and decomposers break down their bodies and release carbon dioxide into the atmosphere.

    (6) New plants and animals continue the carbon and oxygen cycles.

19. In the nitrogen cycle, nitrogen gas in the atmosphere is converted into nitrates by certain bacteria and lightning.

20. When plants and animals die, nitrogen in their bodies is converted into nitrates by **bacteria** in the **soil**.

21. The increased use of nitrogen fertilizers in farming has added excess nitrogen to the soil in some areas. This excess nitrogen may be converted to nitrates.

22. Nitrogen gas in the atmosphere is converted into nitrates by bacteria and lightning. Plants and animals use these nitrates for growth. When plants and animals die, the nitrogen in their bodies is converted into nitrates by other bacteria. These nitrates are used again by plants and animals or returned to the atmosphere as nitrogen gas through denitrification by certain bacteria. The cycle then starts over again.

23. Decomposing plants and animal wastes contain nitrates and other nutrients.

24. Yes, it is beneficial since compost and animal wastes contain nitrates and other nutrients that are beneficial to growing plants. Composting is also a way to reduce the volume of garbage sent to landfills.

25. Yes, animal wastes could become a problem with today's intensive farming practices. The amount of manure produced by a large feedlot needs a large area to be spread upon. Also, run-off from the feedlot can contaminate the surrounding soil and ground water.

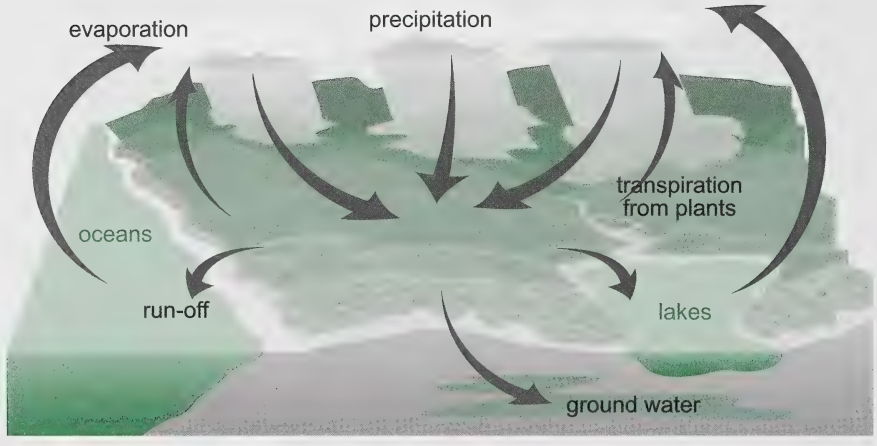
26. Operators of large feedlots could negotiate with grain farmers nearby to have the manure spread on their land. To reduce run-off, they need to remove the manure from the feedlot often.

27. **Textbook questions 1 and 2 of "Check Your Understanding," p. 251**

    1. Matter must be recycled because there is only so much matter in the ecosystem and that amount does not change.

2. Sketches will vary. The landscape only needs to be roughly shown (as shown in the illustrations on pages 248, 249, and 250 of the textbook), but the arrows illustrating the parts of the cycle should be clearly shown. A sample sketch is given.

The Water Cycle



Section 1 Review

1. **Textbook question 1 of "Reviewing Key Terms," p. 252**

   1. a. v b. viii c. i d. iii e. vii

   f. ii g. iv h. vi i. ix

2. **Textbook questions 3, 7, and 8 of "Understanding Key Ideas," pp. 252 and 253**

   3. a. This diagram illustrates a **food web**.

      b. The only producers shown on this diagram are the **grasses**.

      c. Two primary consumers shown on the diagram are the **mouse** and **rabbit**. (Also grasshopper and deer are primary consumers)

      d. Two secondary consumers shown on the diagram are the **shrew** and **mountain lion**. (The snake is also a secondary consumer.)

      e. The decomposers in this diagram are represented by the **earthworm**.

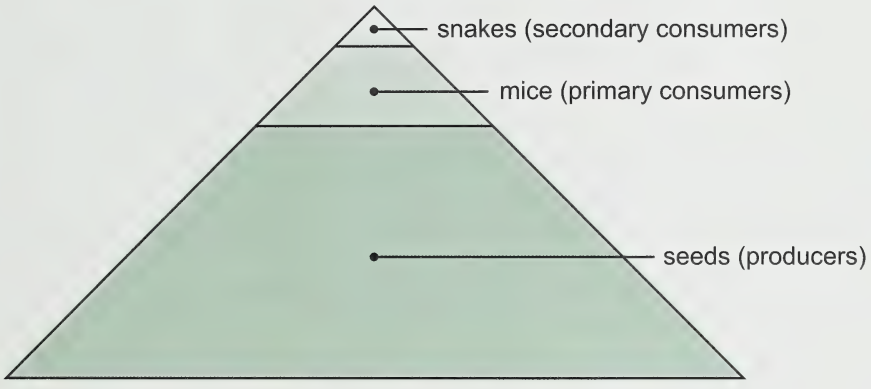
7. The other 90% is used for life processes—cellular respiration, growth, reproduction, and movement. Some is used to maintain normal body temperatures, and some is given off as heat.

8. a. Since energy is lost at each step, food chain 4 has the largest loss of energy because it has the most steps. Also, the size of the organism usually increases as you go up the food chain. The larger organisms have a greater loss of energy.

   b. Food chain 1 loses the least amount of energy because it has only one step and the consumer is a small organism.

   c. You would expect to see more snakes than mountain lions because snakes are closer to the producers in the ecosystem. In most cases, the closer an organism is to the producers, the greater the number of these organisms.

   d.



3. **Textbook question 11 of "Critical Thinking," p. 253**

11. a. Answers will vary. Support for manure over chemical fertilizers could include the following:

   - Manure is a natural product that can be processed by micro-organisms.
   - Manure adds fibre to the soil.
   - Chemical fertilizers are often made up of chemicals that are similar to the waste products of micro-organisms, thus preventing micro-organisms from fulfilling their role.

   b. Bacteria in manure can reach the water supply of humans and other animals. Manure can also pollute streams, rivers, and ground water, especially if it is in large quantities in a small area.

Section 2: Lesson 1

1. a. The population of Edmonton in 2000 appears to be much larger than the population of Calgary in 1884.

   b. The area occupied by Edmonton in 2000 is much larger. Other populations that once occupied this area have most likely been displaced.

2. It is important to learn about populations because you may have to make decisions later in your life that relate to how the human population affects other organisms in the environment. Understanding how population sizes are controlled in nature will help you understand what may happen as the human population grows.

3. **Textbook questions 1 and 2 of "What to Do," p. 255**

   1. Examples of species at risk in Alberta as of August 2003 include the peregrine falcon, whooping crane, wood bison, swift fox, burrowing owl, ferruginous hawk, woodland caribou, piping plover, mountain plover, trumpeter swan, and bull trout.

   2. Answers will vary. A sample action plan is given.

      step 1: Determine what activities are causing the particular species to be at risk.

      step 2: Determine if the problem activities can be eliminated or altered so as not to affect the species.

      step 3: If the activity cannot be eliminated or changed, determine if the species can be relocated.

4. The human population of a town, city, or country is defined as the number of individuals living within the town or city limits or within the country borders.

5. Ecologists define population as a group of individuals of the same species that live together in the same place at the same time.

6. You need to know what the species is, where the species is living or lived in the past, and when the species lived in the given area.

7. You can find out how healthy a population is by calculating the rate at which population is increasing or decreasing. If the population is increasing, then it is healthy. If the population is decreasing, then it is not healthy.

8. Burrowing owls live in unused gopher holes.

9. Burrowing owls are active during the day, catching insects and mice. **Note:** They also catch mice and other rodents at night.

10. Female burrowing owls lay 6 to 12 eggs.

11. The burrowing owl sits on the eggs for about 4 weeks.

12. a. Number of adult burrowing owls in 1979 = 2100 x 2
= 4200

b. Number of adult burrowing owls in 1987 = 700 x 2
= 1400

c. Change in population = population in 1987 – population in 1979
= 1400 – 4200
= –2800

The number of burrowing owls decreased by 2800 from 1979 to 1987.

d. 1987 – 1979 = 8 years

$$\text{Average annual rate of change} = \frac{\text{change in population}}{\text{number of years}}$$

$$= \frac{-2800}{8}$$

$$= -350$$

The average annual rate of change in the population of burrowing owls from 1979 to 1987 is –350 owls/year.

13. **Textbook questions 1, 2, and 3 of "What Did You Find Out?," p. 257**

1. Yes, as a naturalist, you would be concerned about the population of the burrowing owl because it is decreasing rapidly.

2. Answers will vary. You may have factors like the following:

- loss of habitat due to an increase in cultivated land and fragmentation of pasture land

- loss of burrows (unused gopher holes and badger holes) due to a decrease in population of burrowing animals, like gophers

- loss of food source (insects, mice, etc.) due to pesticide use
- increase in predators (badgers, coyotes, foxes, etc.)

3. You may have said that the population of the burrowing owl has continued to decrease. Actually, the burrowing owl was placed on the endangered species list in 1995.

14. **Textbook questions 1 to 4 of "Check Your Understanding," p. 257**

1. Answers will vary. A sample answer is given using moose in the County of Thorhild in 2003 as an example.

   Individual refers to one moose in the County of Thorhild in 2003. *Population* refers to the total number of moose in the County of Thorhild in 2003.

2. a. The time and/or date is not given.

   b. The time and/or date is not given.

   c. The location is not given.

3. a. Calculate the change in population.

$$\begin{aligned}\text{Change} &= \text{1940 population} - \text{1930 population} \\ &= 15 - 30 \\ &= -15\end{aligned}$$

Calculate the number of years.

$$1940 - 1930 = 10$$

$$\therefore \text{Rate of change} = \frac{\text{change in population}}{\text{number of years}}$$

$$= \frac{-15}{10}$$

$$= -1.5$$

The population of grey wolves decreased by 1.5 grey wolves/year in this period.

b. Calculate the change in population.

Change = 1990 population – 1970 population
= 10 – 4
= 6

Calculate the number of years.

1990 – 1970 = 20

$$\therefore \text{Rate of change} = \frac{\text{change in population}}{\text{number of years}}$$

$$= \frac{6}{20}$$

$$= 0.3$$

The population of peregrine falcons increased by 0.3 peregrine falcons/year in this period.

4. Wolf populations outside the park were probably negatively affected by changes in habitat. The peregrine falcon was seen as being at risk and has been successfully supported as a species at risk.

Section 2: Lesson 2

1. Birth rate, death rate, immigration, and emigration are the four factors that affect the size of a population.

2. Birth rate is the number of new organisms that are born to a population over a period of time (usually 1 year). Birth rate increases the size of a population.

3. Four factors that affect birth rate are as follows:

   - environmental conditions (Good environmental conditions allow for a high birth rate, and poor environmental conditions contribute to a low birth rate.)
   - nutrition (Well-fed mothers have and raise healthier babies.)
   - density of the population (Crowded areas have fewer babies born.)
   - the number of young that are produced by each mature female each year

4. Death rate is the number of organisms in a population that die over a period of time (usually 1 year). Death rate decreases the size of a population.

5. Three factors that affect death rate are as follows:

    - predation (being eaten by a predator)
    - disease
    - competition for food

6. Immigration is the number of organisms of a population that come into an area from another area. Immigration increases the size of a population.

7. Organisms may immigrate to a new area because there was a shortage of food in the area they were in.

8. Emigration is the number of organisms in a population that leave an area. Emigration decreases the size of a population. **Note:** Emigration is usually used when the individual leaves an area for an extended period.

9. Organisms may emigrate from an area in search of a new food supply. Fish may emigrate from an area to spawn. Beavers may emigrate from an area if the water level gets too low.

10. Most fish that enter irrigation canals would die because canals do not have an adequate food supply and because the water levels will get too low after the water is used for irrigation.

11. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 260**

    1. Birth rate and immigration are factors responsible for increasing the size of a population.

    2. Death rate and emigration are factors responsible for decreasing the size of a population.

    3. If environmental conditions are good (enough food, stable weather, etc.), the birth rate will be higher. If conditions are poor (lack of food, severe unstable weather, etc.) the birth rate will be lower.

Section 2: Lesson 3

1. *Limiting factors* are factors that slow down the growth of a population.

2. Light, food, water, and space are four limiting factors.

3. The most important limiting factor for a population of mosquitoes is water.

4. Carrying capacity is the number of individuals that an environment can support.

5. The amount of resources affects the carrying capacity of an environment.

6. The graph in Figure 13.5 would be used to show the growth of a mosquito population when conditions are wet. Although it often seems like the mosquito population increases without limit (as shown in Figure 13.4), there are always some limiting factors that limit the carrying capacity of an environment.

7. *Abiotic limiting factors* are factors of the non-living environment that affect the lives of organisms. Three abiotic limiting factors are water, matter, and weather.

8. Abiotic limiting factors limit the size of a population by decreasing the **birth rate** and increasing the **death rate** of living organisms.

9. A lack of matter, such as carbon and nitrogen, can slow the growth of plants in a given area. The reduced plant growth, in turn, will limit the number of individuals of each population that lives in the area.

10. a. Since soil conditions are dry, the number and size of individual grass plants are severely limited. A reduced amount of grass means the pasture will not support as many cattle as it could when conditions are wetter.

    b. The farmer can increase the grazing area for his cattle by renting more pasture land or moving some cattle to a community pasture (if available). The farmer can also bring in additional feed grown in another area.

11. Answers will vary. A sample hypothesis is given.

    The pH of the water will affect the germination of the seeds.

12. Your completed table should be similar to the following.

	Petri Dish 1 (vinegar)	Petri Dish 2 (tap water)	Petri Dish 3 (sodium hydroxide)
pH	3	7	11
Acid, Base, or Neutral?	acid	neutral	base
Appearance of Seeds After 1 Day	Seeds are pale in colour. No seeds germinated.	No change in appearance. One seed germinated.	Seeds are dark in colour. No seeds germinated.
Appearance of Seeds After 2 Days	Seeds are pale in colour. No seeds germinated.	No change in colour. Two seeds germinated.	Seeds are dark in colour. No seeds germinated.
Appearance of Seeds After 3 Days	Seeds are pale in colour. No seeds germinated.	No change in colour. Six seeds germinated.	Seeds are dark in colour. No seeds germinated.
Appearance of Seeds After 4 Days	Seeds are pale in colour. No seeds germinated.	No change in colour. Eight seeds germinated.	Seeds are dark in colour. No seeds germinated.

13. **Textbook questions 1 and 2 of "Analyze," p. 263**

    1. The most seeds germinated in petri dish 2. The pH of the water in this dish was approximately 7.

    2. No seeds germinated in either dish 1 or dish 3. The pH of the liquid in these dishes was approximately 3 and 11 respectively.

14. The pH of water used to make plants germinate or grow is an abiotic limiting factor. In this investigation, the pH affected how well the seeds germinated.

15. Answers will vary. The results supported your hypothesis if you said that pH will affect the germination of the seeds.

16. **Textbook questions 1, 2.a., and 2.b. of "Check Your Understanding," p. 263**

    1. a. Light would limit the growth of seedlings on a forest floor.

       b. Soil conditions and temperature would limit the growth of trees on a mountain side.

       c. Water and temperature would limit the growth of plants in a desert.

    2. a. Warm weather with rain increases the population of mosquitoes quickly between June and September.

       b. Cooler temperatures and drier conditions decrease the population of mosquitoes between September and November.

Section 2: Lesson 4

1. Parasitism, predation, and competition are three biotic limiting factors.

2. *Competition* is when organisms compete for resources, such as food (nutrients), shelter, light, and water.

3. Yes, organisms from different species often live among each other and compete for the same resources.

4. *Parasitism* is a relationship between two organisms in which one organism lives on or inside and feeds on the other organism, called the host.

5. External parasites and internal parasites are the two types of parasites.

6. A parasite weakens its host organism.

7. a. The moose is the host organism.

   b. The tick is the parasite.

8. *Predation* is a relationship in which an animal catches, kills, and eats another animal.

9. Predation often takes out the sick and weak individuals of a population. So, the population, in general, becomes stronger. Also, there is less competition for food.

10. Parasites affect the predator-prey relationship by weakening some individuals in a population. These individuals then become prey for a predator.

11. One predator-prey relationship is the lynx and the hare. Another is the yellow warbler and the caterpillar.

12. The deer and the snowshoe hare both eat grass; they are competing for the same food.

13. **Textbook questions 1.a., 1.b., 1.c., 1.d., 2, and 3 of "What Did You Discover?," p. 266**

    1. a. There was a fairly large population of lynx in 1845. The lynx would have eaten a large number of snowshoe hares, decreasing the snowshoe hare population.

       b. Once the snowshoe hare population had been depleted, the number of lynx would go down due to lack of food.

       c. Since the number of lynx had decreased significantly, the snowshoe hare now had fewer predators and its population increased quickly.

       d. With the increase in the snowshoe hare population, the lynx had a large amount of food and, thus, increased in population.

    2. Since the snowshoe hare population had increased so much, they are competing for food, shelter, and water. Also, disease may have spread rapidly among the large population of hares.

    3. Yes, mosquitoes, for example, would have similar cycles except that the cycle could occur several times a year depending on the amount of rainfall. Areas that have more consistent, shallow bodies of water would have fluctuations depending on the number of birds, dragonflies, and bats that prey on mosquitoes.

14. Earth is not overrun with houseflies because they have a high death rate, a short life span, and a large number of predators. Also, there is a limited supply of food for the larvae.

15. Species that have low reproductive rates tend to care for their young to ensure the survival of the species.

16. **Textbook question 1 of "Check Your Understanding," p. 267**

    1. a. predation b. competition c. parasitism d. predation

Section 2: Lesson 5

1. Examples of exotic species that have been introduced to Canada include

    - Atlantic salmon
    - purple loosestrife
    - chestnut blight
    - English sparrows
    - sea lampreys
    - Norway rats

2. Exotic species can over populate a region and displace other plants or animals because they have no natural enemies in that region. For example, the purple loosestrife reproduces very quickly and replaces plants native to an area where it grows. Sea lampreys have endangered the survival chances of many species of fish in the Great Lakes and St. Lawrence Seaway.

3. Salmon farmers want to continue raising Atlantic salmon because they grow much faster than Pacific salmon.

4. Scientists are worried that Atlantic salmon may interbreed with the native Pacific salmon. This could possibly damage the ability of the Pacific salmon to breed.

5. Invasive plants is another name for exotic plants.

6. Yes, the purple loosestrife could be called an invasive plant because it is not native to North America.

7. Answers will vary. A sample pamphlet is given.

Exotic Species

What Are Exotic Species?

Exotic species are plants or animals that are brought into a country from another country.

Why Are Exotic Species a Problem?

Exotic species are a problem because they may have no natural enemies in the new location and may multiply quickly, overtaking other plants or animals.

What Other Things May Be Brought In When You Bring Plants or Animals in from Another Country?

When you bring plants or animals in from another country, you may unknowingly bring other species in with it (e.g., seeds attached to the fur of animals, seeds or insects in the soil of a potted plant). You may also bring diseases with the plants or animals.

Example of an Exotic Species

Purple Loosestrife

- Brought in by gardeners for its beauty
- Takes over other species of plants in wetlands

8. Dragonflies, swallows, frogs, and bats depend directly on the mosquito for food. Fish, mallard ducks, great horned owls, and snakes depend indirectly on the mosquito for food.

9. A natural method of controlling mosquitoes is to increase the number of predators of the mosquito.

10. When chemical sprays are used to control the mosquito population, the dragonfly and frog populations also decrease; however, their populations take longer to decrease.

11. The fish and frog population reduce to near zero because the mosquito habitats that are destroyed are also fish and frog habitats.

12. Mosquito eggs can remain dormant for as long a five years.

> **Note:** This information is provided in "Did You Know?" in Part 6 of the applet.

13. It is not good to try to eliminate the mosquito population because many organisms depend on the mosquito as a food source. In turn, these organisms provide food for other organisms. So, if the mosquito is eliminated, the food source for other organisms up the food chain will also be eliminated.

14. **Textbook question 1 of "Check Your Understanding," p. 269**

    1. The population of this bird will increase quickly because it has no natural enemies. Over time, the population could reach the carrying capacity of the area and, thus, the population will begin to die off. Also, other bird species in the area that will compete for the same food source will be severely affected.

Section 2 Review

1. **Textbook question 2.d., 2.e., 4, and 5 of "Understanding Key Ideas," p. 270**

    2. d. The main idea of abiotic limiting factors appears on page 261 of the textbook. Abiotic limiting factors are non-living factors in the physical environment that limit the size of a population. Factors include soil, water, light, temperature, and weather conditions.

    e. The main idea of biotic limiting factors appears on page 264 of the textbook. Biotic limiting factors are ways in which living organisms affect the size of a population. Factors include competition, predation, and parasitism.

    4. Population B is increasing. In population A there are just as many deaths as births and 20 more individuals per year leaving than arriving. The net result is a decrease of 20 individuals per year. In population B there are 100 more births than deaths and only 20 more leaving than arriving. So, the result is an increase of 80 individuals per year.

5. Factors that could explain why one population is increasing while the other is staying about the same include food and water supply, predation, parasites, and competition with individuals of other species.

2. **Textbook question 9 of "Problem Solving/Applying," p. 271**

   9. Predators often only kill the weak, sick, or old individuals of a population. These individuals are the easiest to catch. If there is a large population of prey, the predators will even find it relatively easy to catch and kill some of the healthy animals and some of the young during the birthing season. Once the surplus is removed, however, the predators will find it more difficult to catch the healthy prey.

Section 3: Lesson 1

1. **Textbook questions 1 to 4 of "What Did You Discover?," p. 273**

   1. The northern forests were not logged and had an abundance of animals. The grasslands were not ploughed and had a variety of plants and animals native to the area.

   2. The logging and farming 100 years ago had a minimal effect on the forests and grasslands. The number of trees logged by hand and taken out with horses was small compared to the number of trees in the forest. The farms were small and few in number. Much of the grasslands remained in their native state.

   3. Many of the plants and animals would die because they depend on the forest for shelter. Some of the animals would move (emigrate) to other regions.

   4. Many of the native plants would die out or be treated as weeds and killed with chemicals. Animals depend on native plants for food. With the food supply depleted, animals would die out or move on to other areas.

2. An ecosystem is made up of the living and non-living factors in an environment.

3. The living components of an ecosystem are called the biotic community.

4. The non-living components of an ecosystem are called the abiotic environment.

5. No, an ecosystem can be large or small.

6. The underside of a leaf, the underside of a stone, and an anthill are examples of a small ecosystem. A forest, a lake, and Banff National Park are examples of large ecosystems.

7. The three conditions for ecosystems are as follows:

    - Living things interact with one another.
    - Living things interact with other species.
    - Living things interact with their environment.

8. You should have noticed some of the following:

    - The earthworms moved into the soil.
    - The plant seeds germinated after about three days and grew to a height of about 3–5 cm over the two weeks
    - Condensation formed on the inside of the bottle, particularly once the plants started to grow.
    - The soil temperature and interior temperature rose in the sunlight.
    - You may see some additional bugs in your ecosystem over the two weeks.

9. The abiotic factors are the soil, sand, gravel (or charcoal), dry leaves (or vegetation), water, sunlight, and plastic bottle.

10. The biotic factors are the earthworms, plants, and any additional insects that may be living in the soil.

11. The model ecosystem is similar in that plants and animals interact with each other and use nutrients from the abiotic environment to grow and live. Water and soil matter are necessary to make a suitable abiotic environment. Sunlight helps to provide warmth and evaporate water to form the condensation.

12. **Textbook questions 1 and 2 of "Check Your Understanding," p. 275**

    1. a. Sunlight is part of the abiotic environment. It provides warmth for animals and is the energy source through photosynthesis for plants. Indirectly, the Sun is also the energy source for animals.

       b. Mould is part of the biotic community, and the dead leaf is part of the abiotic environment. The dead leaf provides food for the mould and a place (structure) for the mould to grow.

c. Both the spider and the fly are part of the biotic community.

d. Minerals in the soil are part of the abiotic environment. Minerals are essential for both plants and animals for proper growth.

e. Carbon dioxide is part of the abiotic environment. It is an important component of the process of photosynthesis.

f. A green plant is part of the biotic community.

2. Animals require plants as a food source, either directly or indirectly. Plants, in turn, use nutrients from animal wastes and decaying dead plants and animals. Plants use carbon dioxide from respiration for photosynthesis and provide oxygen for animals. Animals also depend on other animals for food.

Section 3: Lesson 2

1. *Weather* is the short term, day-to-day conditions of a particular region. Weather includes conditions such as temperature, precipitation, wind, cloud cover, and air pressure.

   Climate is the average weather conditions for an area over hundreds of years.

2. Two main conditions of climate are as follows:

   - The temperature is within a certain range within each season.
   - The average annual precipitation is within a certain range within each season.

3. Weather is what happens in terms of temperature, precipitation, winds, cloud cover, and air pressure from day to day. Climate is an average of the weather conditions in an area over hundreds of years.

4. Climate is important because it affects living things. Living things are adapted to the particular climate in which they live. For example, many living things have reproductive cycles that fit with the weather conditions of the area.

5. Polar bears don't live in tropical regions because they are adapted to live in a cold climate.

6. Mountains influence climate by pushing air up where it cools and forms clouds, thus resulting in precipitation. Once the air gets over the mountains, it is drier. So, areas on the other side of the mountains do not get much precipitation. An example of this is southern Alberta (from Calgary to the Alberta-U.S. border).

7. The three factors that influence the climate of any region are topography, latitude, and altitude.

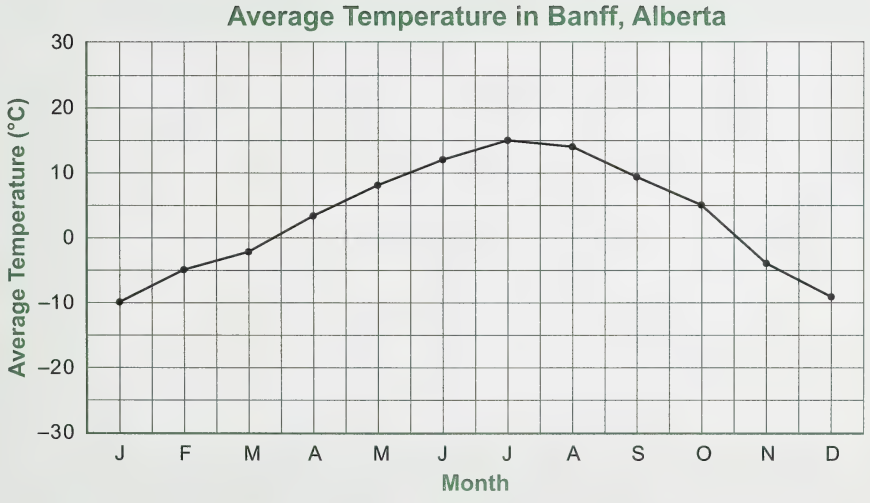
   Topography refers to the physical features of the area, such as the presence of lakes and rivers, streams, hills, valleys, and mountains.

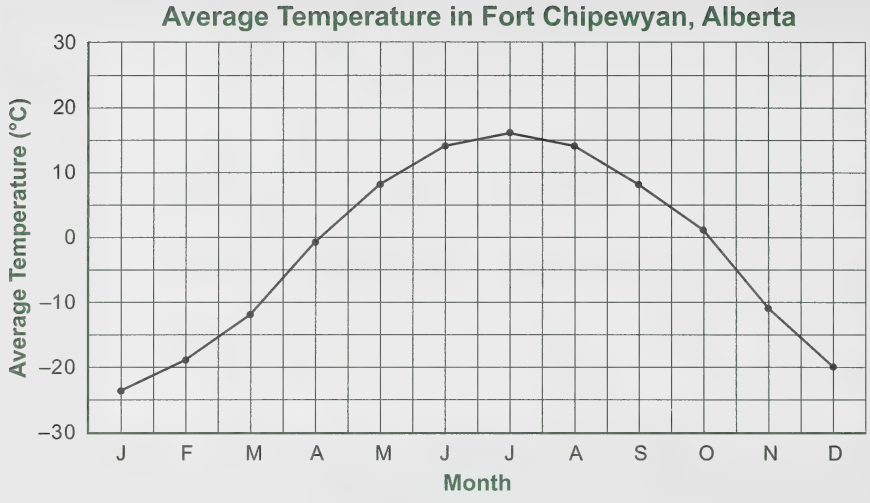
   Latitude refers to how far north or south a region is from the equator. This affects the amount of energy the region gets from the Sun.

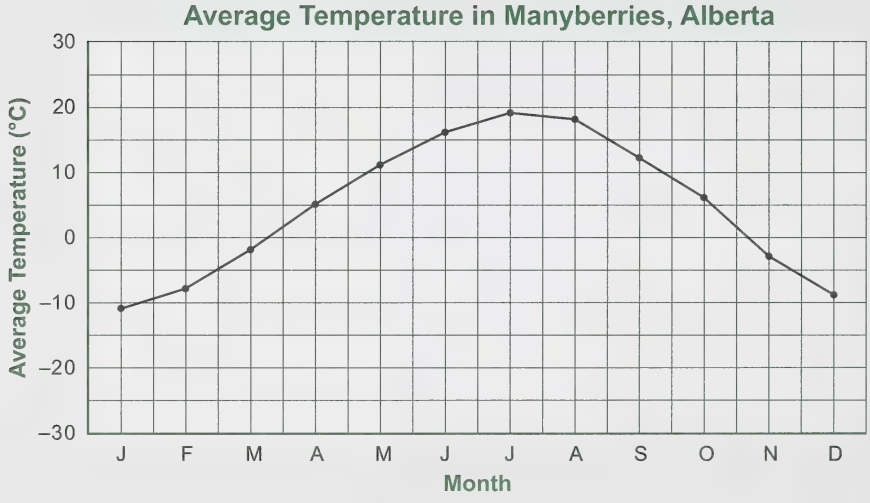
   Altitude refers to the height above sea level of a region. The very high elevation is cold and dry.

8. **Textbook questions 1, 2, and 3 of "What to Do," p. 277**

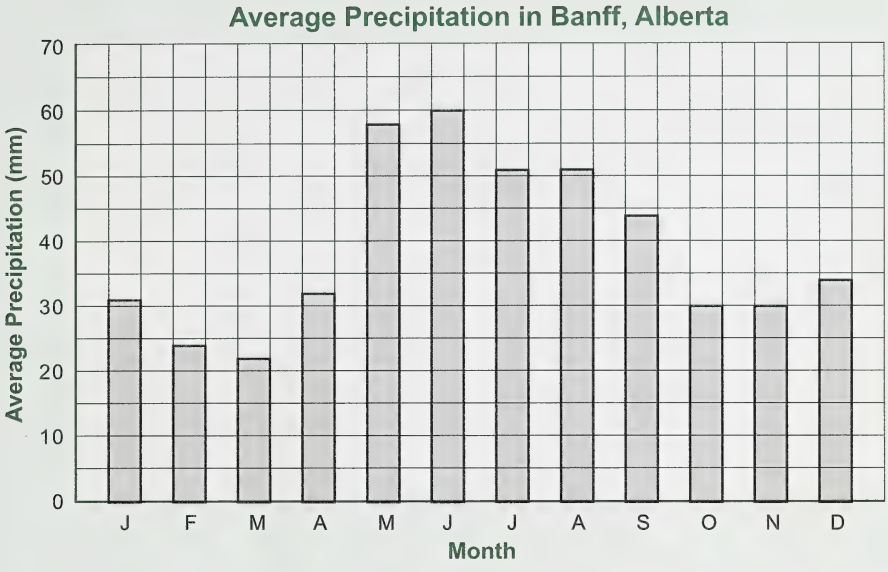
   1. Your temperature graphs should be similar to the following.

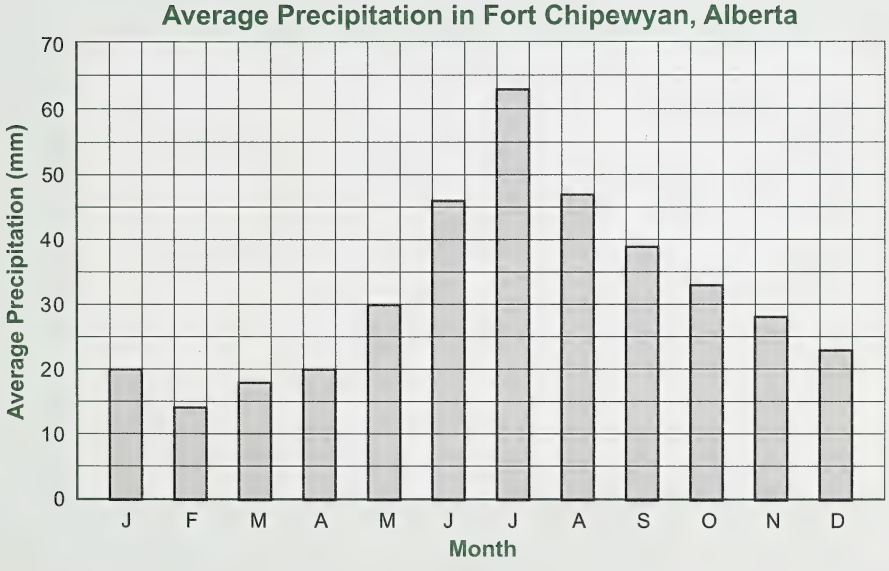


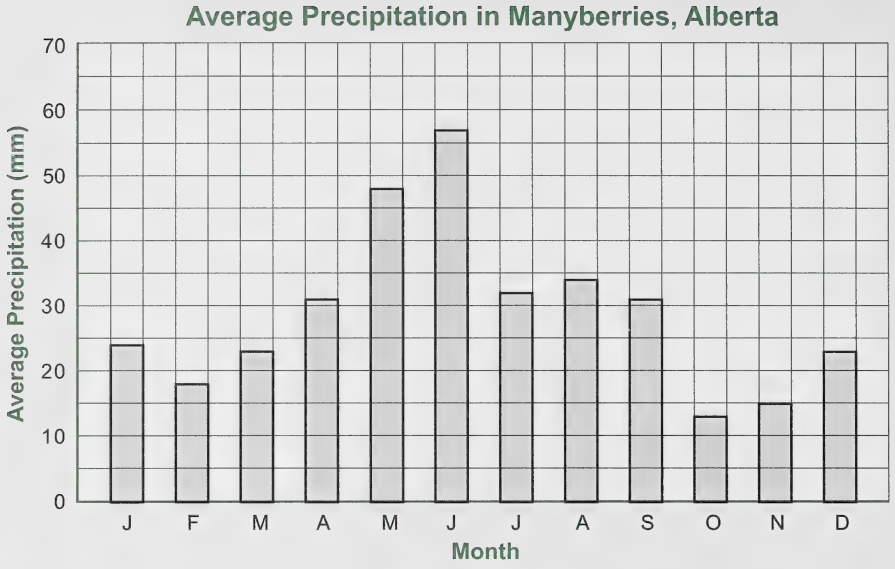

Average Temperature in Fort Chipewyan, Alberta
Average Temperature (°C)
30
20
10
0
−10
−20
−30
J F M A M J J A S O N D
Month


Average Temperature in Manyberries, Alberta
Average Temperature (°C)
30
20
10
0
−10
−20
−30
J F M A M J J A S O N D
Month

2. Your precipitation graphs should be similar to the following.







3. **Banff**

Total precipitation = 31 + 24 + 22 + 32 + 58 + 60 + 51 + 51 + 44 + 30 + 30 + 34
= 467 mm

Fort Chipewyan

Total precipitation = 20 + 14 + 18 + 20 + 30 + 46 + 63 + 47 + 39 + 33 + 28 + 23
= 381 mm

Manyberries

Total precipitation = 24 + 18 + 23 + 31 + 48 + 57 + 32 + 34 + 31 + 13 + 15 + 23
= 349 mm

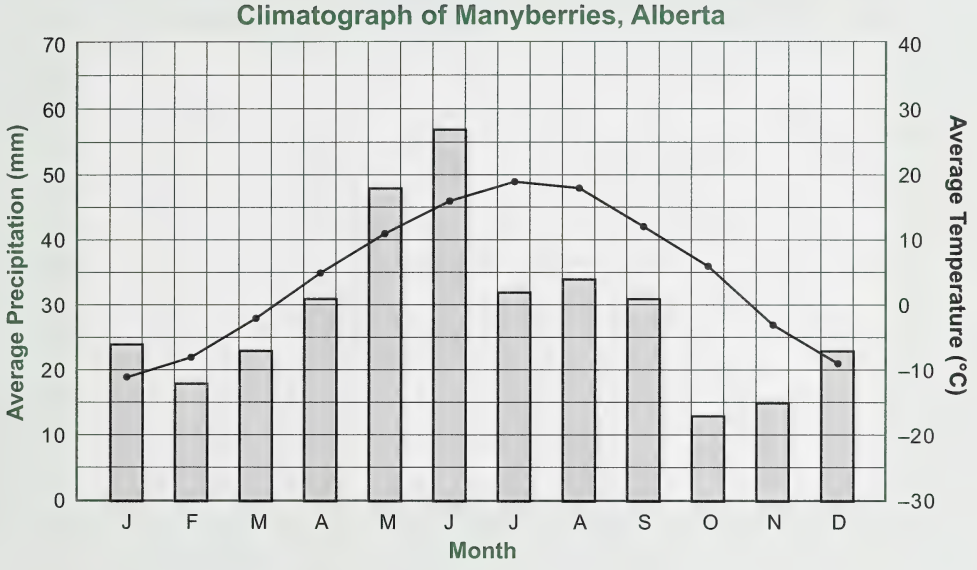
9. **Textbook questions 1, 2, and 3 of "What Did You Discover?," p. 277**

1. The climate gets cooler as you move north.

2. Banff has milder winters than Fort Chipewyan since Banff is further south. Banff is cooler and wetter in the summer months than Fort Chipewyan and Manyberries because it is at a higher elevation and is in the mountains where more moisture arrives from the Pacific coast.

3. Manyberries is well east of the mountains. Because the air flow in the area is usually from west to east, most of the moisture has already been dropped on the western (upslope) side of the mountains. Banff is within the mountain ranges and so is affected by an upslope side of a mountain range.

10. Your climatograph should be similar to the following.



11. The temperature drops 2.7°C for every 500 m.

$$\text{Temperature change for 4000 m} = \frac{4000}{500} \times 2.7°C$$
$$= 8 \times 2.7°C$$
$$= 21.6°C$$

$$\text{Temperature} = 15°C - 21.6°C$$
$$= -6.7°C$$

The temperature at the top of the mountain is predicted about –6.7°C.

12. **Textbook questions 1 and 2 of "Check Your Understanding," p. 277**

1. The climate of an area is the average temperature and precipitation over hundreds of years. Generally, climate is influenced by location (latitude), altitude (height), and topography (presence of mountains, hills, valleys, large bodies of water, rivers, and streams).

2. It is colder near the North and South Poles because the angle of the Sun is very oblique (slanted). The energy received from the Sun is less at the two poles than near the equator, where the angle of the Sun is nearly perpendicular all year long.

Section 3: Lesson 3

1. *Soil* is the thin layer of pulverized rock fragments along with decomposed plant matter that covers the land.

2. Soil is composed of different sizes of rock particles along with organic matter. The smallest particles are clay. Silt and sand are slightly larger particles that are mixed in with clay. Gravel makes up the largest rock particles of soil.

3. Soil provides nutrients, traps and holds water, and gives a firm support base for plants.

4. Animals are affected by soil types because they eat plants that depend on the type of soil in the location.

5. Humus is made up of fibres, soil particles, and the decayed remains of organisms. Humus also contains bacteria, fungi, and moisture.

6. Soil crumbs are soil particles of various sizes bound together by humus.

7. Soil crumbs are good for plants because there are spaces between the crumbs that allow roots to grow and air to move into the soil. Soil crumbs hold moisture but allow excess water to drain away. Soil crumbs are also less likely to be blown away by the wind.

8. Leaching is the washing out of soil materials (such as minerals) by rain.

9. After a period of time, humus is broken down completely by bacteria, leaving only its valuable minerals behind.

10. Humus is maintained by the continual decay of plant and animal material.

11. There are three layers in most types of soil in North America. Starting from the top layer, they are named Horizon A, Horizon B, and Horizon C respectively.

12. Answers will vary. Your completed table should be similar to the following.

Soil Location	Relative Thickness of Horizon		General Description of Location	Precipitation Estimate	Role of Decomposers
	A	B			
grassland	twice as thick as Horizon B	half as thick as Horizon A	open areas, few trees, grass fields	low to moderate amounts of precipitation	eat dead plants and animals, break down wastes
forest	thin layer compared to Horizon B	thick layer compared to Horizon A	lots of trees, bogs, animals	moderate to heavy amounts of precipitation	eat dead plants and animals, break down wastes
desert	very thin layer compared to Horizon B	thick layer compared to Horizon A	few plants and animals	low amount of precipitation	eat dead plants and animals, break down wastes

13. The grassland area has the thickest layer of Horizon A.

14. The forest area has the most precipitation.

15. The topsoil in the grassland area is the thickest because there are lots of dead plant and animal matter to decompose. Also, the amount of precipitation is not excessive to cause leaching into the second layer.

16. The grassland soil would be best for growing grain. The soil provides a good supply of nutrients and adequate water absorption for good root development.

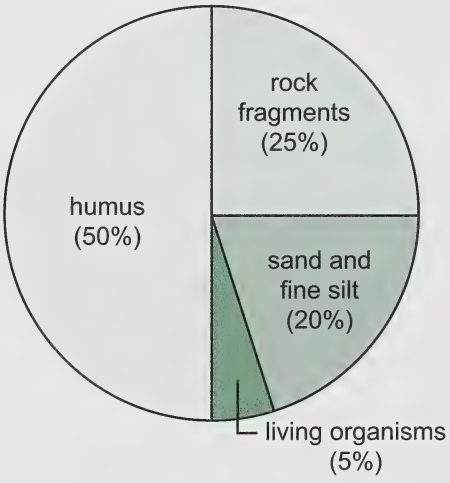
17. **Textbook questions 1 to 4 of "What Did You Discover?," p. 280**

1. Answers will vary. You should have two or three layers with the largest and heaviest particles on the bottom. A sample diagram is given on the right.

2. The gravel and sand particles are the heaviest since these particles are large and dense. The humus particles and fine silt particles are the lightest. The heaviest particles will settle to the bottom first.

3. The particles varied in size, colour, and texture. Some broke apart easily, and some living insects were present.

4. Answers will vary. You could have as much as 50% for humus if you had good garden soil. Rock fragments might be about 25%, sand and fine silt about 20%, and living organisms about 5%. The following is a sample pie graph.



18. **Textbook questions 1 and 3 of "Check Your Understanding," p. 280**

1. Soil is important because it

- traps and holds water but allows excess water to drain away
- provides nutrients and minerals necessary for plant growth
- gives a firm base for plants to grow
- provides an environment for organisms that are beneficial to plants

3. Precipitation helps plant growth. If the amount of precipitation is moderate, you get good plant growth. When the plants die, they produce humus that makes good topsoil. If the amount of precipitation is excessive, the minerals leach down to the next layer. This leaves a thin layer of topsoil (Horizon A) and a thicker layer of subsoil (Horizon B). If the amount of precipitation is low, you get very little plant growth. The top layer of soil is thin and has little humus, and the layer of subsoil (Horizon B) is thinner and poorer in quality.

Section 3: Lesson 4

1. A biome is a large geographic region with distinct plants and animals.

2. The four biomes of Alberta are boreal forest, parkland, mountain and foothill, and grassland.

3. There would be more spruce and pine mixed with the aspen as you move into the boreal forest biome. The parkland biome would be mostly aspen. There would also be more animals (moose and deer) and insects (mosquitoes) in the boreal forest region.

4. The feature that makes the mountain and foothill biome distinct is the altitude (or elevation) of the region.

5. The parkland and grassland biomes are the two biomes used mainly for farming today. There is some farming within the other two major biomes, but it is not as intensive.

6. The climate in the northern boreal forest is cold in the winter and can be surprisingly hot in the summer. There is enough precipitation to support trees.

7. The cold climate and acidic soil slow the action of bacteria in the soil in this region. Earthworms are rare, so the needles of trees and dead organisms decay slowly.

8. Animals in this region adapt by growing thicker hair that turns white in the winter, by migrating, or by hibernating during the cold months.

9. Plants like low bush cranberry and lichens grow in this biome. Both are able to grow in low air and soil temperatures and in poor soil conditions. The southern parts of this biome include trees such as aspen, pine, spruce, and willow.

10. There are many species of organisms in this area. As shown in Figure 14.6, there are large mammals, small mammals, birds, and many insects living in this biome.

11. Few trees grow in the grassland biome because of low year-round precipitation, drying winds, cold winters, late-spring storms, and summer droughts.

12. Animals that can run swiftly or hide in burrows live in the grassland biome. Burrows also provide protection from heat in the summer and cold in the winter.

13. A large number of insects attract a large variety of birds. Also, many sloughs present in the grassland biome provide a place for water insects and water birds.

14. Your completed chart should be similar to the following.

Biome	Climate	Plant Life	Animal Life
grassland	• cold winters, hot summers • low precipitation • spring storms	• mostly grasses, short plants, flowers, and cactuses • sloughs with water plants	• small mammals, pronghorns, and rattlesnakes • wide variety of birds and insects
northern boreal forest	• cold winters (colder than grasslands) • some summer days hot • enough precipitation to support trees	• dense forest with mostly coniferous trees, some aspen and willow • moss and lichens	• moose, caribou, wolves, lynx, and various rodents • variety of birds, insects, fish, and frogs

15. **Textbook questions 1, 2 and 3 of "Check Your Understanding," on p. 285**

    1. Answers will vary. If you live in Slave Lake, for example, you are in the boreal forest biome. You have mixed forests of spruce and pine, with some aspen (poplar). Usually, you have a moderate amount of precipitation. Winters are long and cold, and some summer days are hot. Hours of daylight are long in the summer and short in the winter. Moose, weasels, chipmunks, and various birds and insects are common to the area.

    2. a. Coniferous trees are adapted for poor soil conditions and low temperatures. They do not lose their needles in winter, so they conserve energy and nutrients. Also, the needles are waxy and have a small surface area to reduce evaporation in the summer.

       b. Bushes like the low-bush cranberry produce berries that remain on the bush through the winter and provide food for birds.

3. a. Prairie grasses have long roots to absorb water and nutrients from deep down in the ground. The grass leaves grow from the base of the plant, allowing it to grow even after much of the leaves have been eaten or burned in a fire. Also, grasses produce a large number of seeds to provide for new plants.

   b. Other producers have adapted to this region by being short and having leaves that are covered with small hairs to reduce evaporation. Cactuses, for example, have prickly needles instead of leaves to reduce evaporation and keep animals from eating them.

Section 3: Lesson 5

1. Extinction is the elimination of a species from Earth.

2. No, extinction is a normal process. Some species became extinct due to the last ice age or due to catastrophic events, like volcanic eruptions.

3. The main reason for the increased rate of extinction over the past 100 years is the loss of habitat for organisms.

4. Four ways in which humans have affected organisms' habitats are as follows:

   - filling in wetlands
   - clear-cutting forests
   - ploughing up grasslands and putting up fences
   - building dams or diverting rivers to flood large areas

5. *Species at risk* is a term used for organisms that are close to extinction.

6. Two species that are at risk are the black-footed ferret and the cryptanthe plant.

7. The passenger pigeon was made extinct at the start of the last century.

8. **Textbook questions 1 and 3 of "Check Your Understanding," on p. 287**

   1. Some species become extinct because of natural changes on Earth. During the last ice age, the woolly mammoth became extinct. Some may become extinct due to volcanic eruptions or floods. Dinosaurs may have become extinct due to a meteorite hitting Earth.

   3. a. Ploughing of a native grassland eliminates various plants and animals from that area. If there are no other areas to migrate to, species may become at risk or extinct.

b. Clear-cutting trees eliminates habitats in the area. It also changes the plant life by changing soil composition. This affects the food supply of the area and could result in soil erosion.

c. The rock may destroy some vegetation, animal life, and habitats on its way down the mountain. It also covers an area of the mountain side where it comes to rest.

d. Paving an area that was once wooded or grassy destroys habitats and forces organisms to move or die out.

Section 3 Review

1. **Textbook question 1 of "Reviewing Key Terms," p. 288**

   a. iv b. ix c. i d. ii e. vi

   f. viii g. iii h. v i. vii

2. **Textbook questions 2.b., 2.c., 2.f., 5.a., 5.b., 5.e., 6.a., and 9 of "Understanding Key Ideas," pp. 288 and 289**

   2. b. The role of latitude appears on page 276 of the textbook. Latitude tells you how far you are away from the equator. In general, the further you are away from the equator, the cooler the climate is. Temperature is one factor that determines the type of organisms living in a biome.

   c. Soil appears on page 278 of the textbook. The type of soil determines the type and number of plants that will grow in an area. This, in turn, affects the number of animals that can live in the area.

   f. Biodiversity appears on page 282 of the textbook. Biodiversity is the number and variety of plants and animals living in an area.

   5. a. Lichens and moss can grow at the bottom of a dense forest because they require very little light.

   b. The hare's fur turns white to blend in with the snow in the winter so it is not easily seen by predators.

   e. White pelicans migrate to the Gulf of Mexico to escape the cold climate of their northern nesting area.

6. a. Richardson's ground squirrels stand on their hind legs so they can see over the short grasses of the area for approaching predators.

9. Human activity has contributed to putting species at risk by destroying the habitats of many organisms. This has been done by draining wetlands, ploughing grasslands, clear-cutting forests, and damming rivers.

Section 4: Lesson 1

1. Farmers have turned to technology to help them produce more food because the amount of land for farming is limited. Technology will help farmers produce more food from the existing amount of suitable land. Also, the cost of land and equipment for farming has increased significantly, forcing farmers to try increasing profits.

2. Pesticides are chemicals that kill or control organisms that humans consider to be a pest.

3. Two types of pesticides are insecticides and herbicides. Insecticides kill insects, and herbicides kill plants.

4. Farmers and homeowners use pesticides to kill or control insects or plants that eat or compete with their crop, garden, or lawn.

5. It is estimated that about 30% of the world's food supply is destroyed by pests.

6. DDT is a chemical used to kill insects.

7. Grasshoppers and other insects eat grasses and plants with DDT on it. These insects are then eaten by mice and rats. The mice and rats absorb the DDT and are then eaten by the falcons, hawks, and ospreys. The DDT from the mice and rats then accumulates in these birds.

8. Biological magnification is the process of concentrating a chemical as it moves up the food chain. An organism high up in the food chain eats many of the organisms below it, getting the chemical from each organism it has eaten. These organisms that were eaten also ate many organisms below their level in the food chain, getting the chemical from each organism eaten.

9. Weeds reduce the yield of crops by competing for water and nutrients.

10. A side effect of using pesticides is that some pesticides have been linked to various forms of cancer in humans.

11. The Colorado potato beetle is a very destructive pest of potatoes.

12. When an insect is said to have a natural resistance to an insecticide, it means that the insect will not be killed by the insecticide, even though the insecticide has been sprayed directly on the insect.

13. When an insecticide is developed and applied, some of the insects have a natural resistance to the insecticide and survive. After a number of years, only the insects that have the natural resistance to the insecticide continue to survive and multiply. These insects pass on their ability to survive to their offspring.

14. The chemical companies produce new and stronger insecticides to combat the insect.

15. A weed is any plant that is growing where people do not want it to grow. Yes, wheat plants growing in a newly planted lawn are considered to be weeds.

16. Nitrates are in synthetic fertilizers.

17. A potential hazard of increased fertilizer use is that excessive nitrates can affect the nitrogen cycle.

18. Answers will vary. A sample answer is given.

Bottle	Amount of Fertilizer	Colour on Day 0	Colour on Day 2	Colour on Day 4	Colour on Day 6	Colour on Day 8	Colour on Day 10
1 (control)	0 g	pale green	no change	no change	no change	no change	no change
2	1 g	pale green	increase in green colour	little or no change	little or no change	little or no change	little or no change
3	3 g	pale green	increase in green colour	increase in green colour	little or no change	little or no change	little or no change
4	5 g	pale green	increase in green colour	increase in green colour	increase in green colour	little or no change	little or no change
5	10 g	pale green	increase in green colour	increase in green colour	little or no change	little or no change	little or no change

19. a. **Textbook questions 1 and 2 of "Analyze," p. 295**

    1. The bottle containing 5 g of fertilizer showed the most growth of algae. (The bottle containing 3 g of fertilizer may have shown the most growth in your investigation.) The bottle with no fertilizer showed the least change. The bottle containing 10 g of fertilizer showed that too much fertilizer can stop the growth of algae after a period of time.

    2. Bottle 1 is important because it shows that it is the fertilizer that makes a difference in the growth of algae, not just the amount of time or sunlight.

    b. **Textbook questions 3 to 6 of "Conclude and Apply," p. 295**

    3. Fertilizer will promote the growth of algae up to a certain point. Too much fertilizer can slow the growth rate.

    4. Nitrogen, phosphorus, and potassium are usually present in the greatest amounts.

    5. a. Producers may accelerate in growth for a certain time, but they will slow down and may even die off after a while.

       b. The number of consumers will increase, but they, too, will die out as the carrying capacity of the lake is exceeded.

       c. The number of decomposers will increase dramatically as the amount of organic material to decompose increases. After a while, the oxygen will be used up and most life in the lake will cease.

    6. Cattle wastes enter the pond providing nitrogen for algae to grow. The green colour is the growth of algae.

20. The nitrates that have been washed into a lake come from farmers' fields, golf courses, and lawns.

21. Eutrophication is the buildup of nutrients in an aquatic ecosystem that leads to excessive plant growth and the eventual depletion of oxygen. This results in the death of the aquatic ecosystem.

22. The buildup of nutrients in an aquatic ecosystem starts the process of eutrophication.

23. The introduction of nitrates into a lake causes increased plant growth around the edges of the lake. This blocks sunlight to the deep-water plants, causing them to die off. The accumulation of dead plants provides an abundance of food for the decomposers in the lake. The increased population of decomposers use up the oxygen in the lake, so fish die from a lack of oxygen.

24. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 296**

    1. Adding nitrates to an aquatic ecosystem will increase plant growth. The addition of too many nitrates will slow the growth of or even kill the plants.

    2. Precautions must be taken not to inhale aerosol sprays or the dust from powder pesticides. All chemical pesticides contain substances that can be harmful to humans.

    3. Carnivores eat animals that have eaten plants that have herbicides on them. These herbicides accumulate in the tissues of the animals and are passed on to the carnivores.

Section 4: Lesson 2

1. The three major sources of energy used in Alberta are coal, natural gas, and oil.

2. Fossil fuels were formed from the remains of organisms that lived millions of years ago. The decaying remains filled the swamps and were covered with sediment. The heavy sediment compressed the decaying plant and animal matter and changed it into coal, natural gas, and oil.

3. The environment was considered to be in balance because about the same amount of carbon dioxide was released into the atmosphere by organisms through cellular respiration as was used by producers for photosynthesis.

4. Carbon dioxide is released into the air when fossil fuels are burned.

5. Burning fossil fuels has produced excess carbon dioxide in the atmosphere. There is more carbon dioxide in the atmosphere than is needed for photosynthesis. Therefore, the balance is upset and the amount of carbon dioxide in the atmosphere increases.

6. The greenhouse effect is the result of carbon dioxide and other gases in the atmosphere forming a blanket to trap heat, keeping it from escaping into space.

7. The excess carbon dioxide from the burning of fossil fuels makes the blanket thicker, thus keeping more heat in the atmosphere.

8. Global warming is an increase in Earth's average temperature.

9. Melting of the polar ice caps would result in increased sea levels. This would flood many coastal cities.

   Drastic changes to weather systems on Earth would result in severe weather storms with high winds and torrential rains.

   Droughts on agricultural lands would result in reduced grain production and fewer cattle. This would lead to increased famine worldwide.

10. No, carbon dioxide in the atmosphere is not all bad. Carbon dioxide is needed to maintain a suitable temperature on Earth. If there were no carbon dioxide in Earth's atmosphere, it is predicted that the average temperature on Earth would be about −18°C. Also, plants use carbon dioxide for the process of photosynthesis.

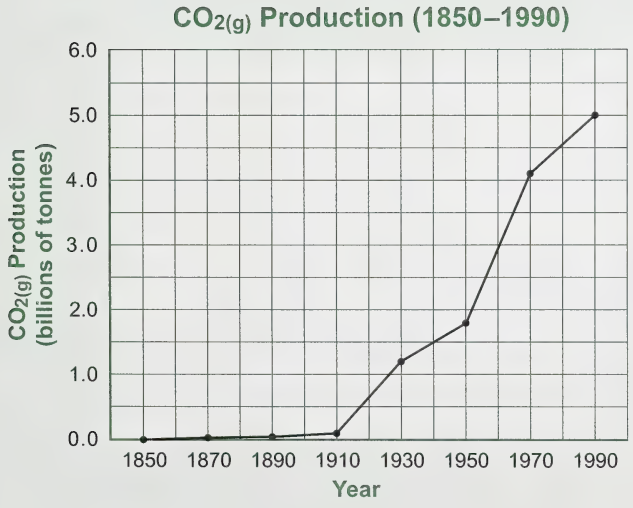
11. **Textbook questions 1 to 4 of "What to Do?," p. 298**

    1. Burning fossil fuels will add carbon dioxide to the atmosphere, thereby increasing the carbon dioxide concentration in the atmosphere.

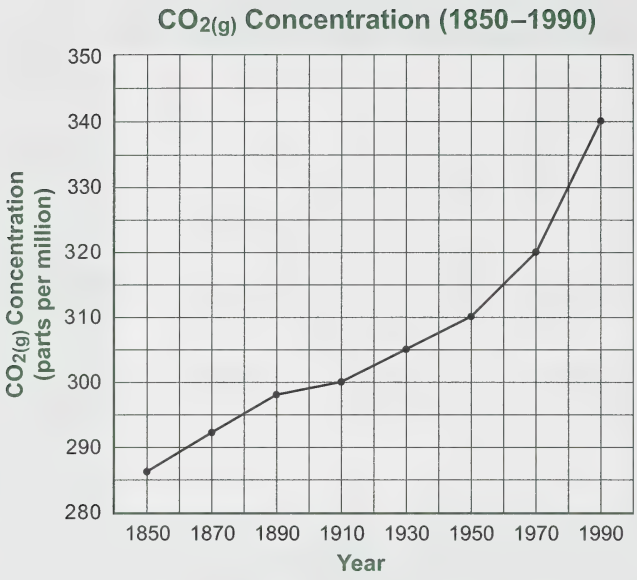
    2. Increasing the concentration of carbon dioxide in the atmosphere will increase the average global temperature.

    3. Your graphs should be similar to the following.

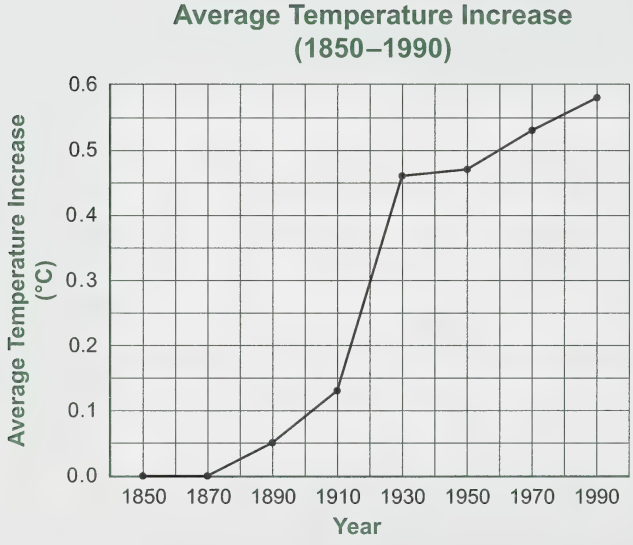
       a.



b.



c.



4. a. The quantity of $CO_{2(g)}$ produced by burning fossil fuels increased slightly from 1850 to 1910. Then the quantity increased rapidly from 1910 to 1990.

   b. The concentration of $CO_{2(g)}$ in the atmosphere increased steadily from 1850 to 1950. It then increased rapidly from 1950 to 1990.

c. The average global temperature increased slightly from 1850 to 1910. It then increased rapidly from 1910 to 1930. From 1930 to 1990, the average temperature increased less rapidly.

12. **Textbook questions 1 to 4 of "What Do You Think?," p. 298**

1. The patterns support both hypotheses. Both the $CO_{2(g)}$ concentration in the atmosphere and the average global temperature increased from 1850 to 1990.

2. Answers will vary. Activities you do regularly that require fossil fuels could include

   - riding in or driving a car or truck (gasoline or diesel)
   - using public transportation (diesel or electricity)
   - cooking food (electricity or natural gas)
   - taking a bath or shower (electricity or natural gas)
   - keeping warm in the winter (electricity, oil, or natural gas)
   - watching television (electricity)

   Note: Electricity often uses fossil fuels, such as coal or natural gas, to produce the steam that drives the electricity-generating turbines.

3. The fossil fuels you use release $CO_{2(g)}$ into the atmosphere.

4. Answers will vary. Lifestyle changes could include the following:

   - walking or cycling where possible
   - using alternate sources of energy (such as solar or wind) where possible
   - turning down thermostats
   - turning off lights in rooms not used
   - re-using containers where possible
   - using products made from recycled materials where possible

13. **Textbook questions 1, 2, and 3 of "Check Your Understanding," p. 298**

1. The demand for energy has increased for several reasons.

   - The number of people on the planet has increased.
   - Populations in Western nations, where a lot of fossil fuels are used, have increased significantly.
   - The number and use of recreational vehicles has increased significantly.

2. We have responded to the demand for energy by locating more fossil fuels and increasing the production of fossil fuels. We have built more coal-fired and natural gas-fired power plants and have dammed more rivers to produce hydroelectricity. Experiments with alternative sources of energy (such as solar energy, wind energy, nuclear energy, and fuel cells) have been conducted.

3. a. The increased burning of fossil fuels has increased the level of carbon dioxide in the atmosphere.

   b. Answers will vary. Although the cost of travel and commuting will increase, increasing the tax on fuel will make people think more about whether they need to travel to a particular place or whether they can find an alternative to driving to work by themselves every day. Increasing the tax on fuel may also make people think more about the fuel efficiency of the vehicles they drive.

Section 4: Lesson 3

1. People preserved foods by drying; canning; preserving in salt; and storing in cold cellars, wells, streams, and ice-boxes.

2. Food spoilage was common with these types of food storage. Sometimes people even died of food poisoning.

3. The fluid used in a refrigerator to remove heat is called a refrigerant.

4. a. Chlorofluorocarbons (CFCs) have been used as a refrigerant in the past. Many products that use CFCs are still in use today.

   b. CFCs were used as a refrigerant because they were thought to be stable, harmless, and non-combustible.

   c. CFCs affected the ozone layer.

5. **Textbook questions 1 to 5 of "Analyze," p. 300**

   1. The ozone layer over the Antarctic became thinner and formed a hole that opens each spring.

   2. Refrigeration using CFCs was developed. The production and release of CFCs has been linked to the thinning of the ozone layer.

3. More UV radiation reaching Earth will increase the amount of skin cancer and cause eye damage in humans. It may also slow the growth of major food crops, thus reducing food supplies. It may kill phytoplankton in the oceans as well, disrupting the marine food chains and food webs. These food chains and food webs include humans, since fish and other marine life are a major source of food for humans.

4. Technology was used to improve conditions by providing refrigerants for refrigerators and for air conditioners in homes, offices, and cars. However, as some of the refrigerant leaked out or was allowed to escape, it caused the thinning of the ozone layer. This was not foreseen and took a number of years before scientists realized what was happening.

5. Chemicals used to replace CFCs in air conditioners and refrigerators are

    - HCFC-22
    - HFCs
    - PFCs
    - FICs

    Other replacements include replacing CFCs with citrus-based solvents to clean circuit boards.

6. **Textbook question 4 of "Check Your Understanding," p. 301**

    4. Other technologies that have caused unforeseen problems in the environment are

        - internal combustion engines—release nitrogen and sulfur compounds into the atmosphere and have become one of the main causes of acid rain and the greenhouse effect

        - batteries—break down and release toxic chemicals that can get into the water system

Section 4: Lesson 4

1. Answers will vary. Some items you may throw away are

    - pop cans
    - plastic wrap
    - potato chip bags
    - juice boxes
    - chocolate bar wrappers

2. A landfill is a location that has been developed to accept garbage and prevent materials from the garbage from entering the environment.

3. Plastic liners help prevent any liquid materials from entering the ground water.

4. **Textbook questions 1, 2, and 3 of "What Did You Discover?," p. 291**

    1. Biodegradable substances are able to break down, returning the nutrients to the environment. **Note:** Some substances that are biodegradable can release harmful substances into the environment. Examples include wood painted with lead-based paints and newspapers printed with petroleum-based inks.

    2. Non-biodegradable substances break down very slowly (over hundreds or thousands of years or not at all). Non-biodegradable items must be stored or buried. This creates land-use problems.

    3. Answers will vary. Having to dispose of your own garbage will create an additional job that would have to be done about every week or two. Additional costs may result. You may find that you need to change how you manage your garbage. You may find that you would try to compost as much as possible, become aware of the type of packaging you purchase items in, start re-using items until they wear out, and try giving away items that are no longer useful to you but useful to others. You may also try to get together with neighbours to dispose of garbage in a common location.

5. a. **Textbook question 1 of "What to Do," p. 302**

    1. The following solutions are based on 30 students in a classroom.

        a. There would be 30 pop cans in the garbage.

        b. Number of hours = 30 cans x 2 h/can
                = 60 h

            You could keep your television going for 60 h with the energy saved by recycling the 30 pop cans.

        c. Number of pop cans = 30 cans/day x 7 days/week
                = 210 cans/week

            There would be 210 pop cans going to the landfill in one week.

d. Number of hours = 210 cans x 2 h/can
= 420 h

You could keep your television going for 420 h with the energy saved by recycling the cans.

b. **Textbook questions 1 and 2 of "What Did You Discover?," p. 302**

1. If just one class of students can put 210 cans into the landfill in one week, think about how many would be put into the landfill by all the students in Alberta. The number of cans saved by recycling is tremendous.

2. Since recycling one can saves enough electricity to run your television for two hours, the amount of electricity saved by recycling all pop cans is very significant. It takes a large amount of energy to produce aluminum from bauxite as compared to the amount of electricity required to make a new pop can from recycled aluminum cans.

6. Canadians throw away a lot of waste because of their high standard of living.

7. Most of the packaging from fast foods ends up in the garbage.

8. The following are three ways to reduce garbage.

(1) Reduce the amount of waste you produce. You can reduce waste sent to a landfill by composting materials and buying in bulk.

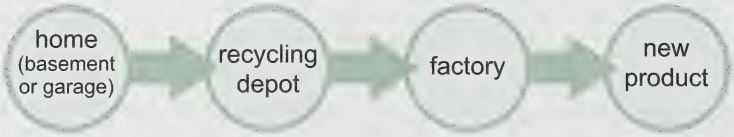
(2) Re-use items, such as glass jars and plastic bags, where possible. Some items, such as magazines, can be shared or exchanged among friends.

(3) Recycle all items that can be recycled. Look for the recycle symbol on items. Recycle glass, cans, juice boxes, paper, plastic, and cardboard. Newspapers are a major item that can be recycled, if your family receives a daily newspaper.

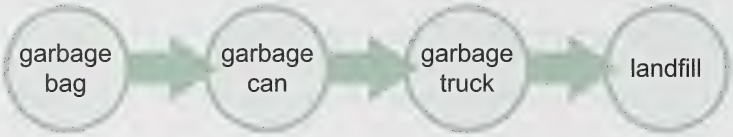
9. Answers will vary. Items may include empty beverage cans and bottles, juice boxes, milk cartons, newspapers, plastics, cardboard, oil containers, and used oil.

10. **Textbook questions 1 and 3 of "Check Your Understanding," on p. 303**

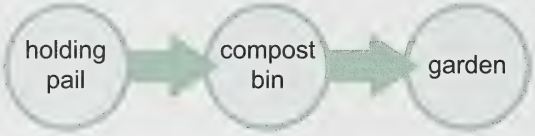
    1. Answers will vary depending on the type of garbage. For items that can be recycled, such as pop cans, the path could be as follows:



    For items that cannot be recycled, the path could be as follows:



    For biodegradable items, the path could be as follows:



    3. Yes, recycling can reduce environmental problems like global warming by reducing energy consumption. Recycling, in some cases, requires less energy than producing an item from raw materials, so less fossil fuels are used. However, many items require more energy to produce a product from recycled materials than from raw materials. An example is producing plastic decking. As a result, the amount of recycling is limited.

Section 4: Lesson 5

1. David Matheson is a habitat specialist with Ducks Unlimited. He is trying to restore areas that were once wetlands back to wetlands.

2. Wetlands are marshy areas that stay wet all year.

3. Wetlands provide habitat for plants and animals, act as a large water filter to help remove chemicals and sediments from water, and help prevent flooding by trapping water and releasing it slowly.

4. Wetlands can be restored by blocking the drainage ditches that were built or by building small dams to keep water back and flood areas that were once wet.

5. You can help wildlife by encouraging people to leave natural areas undisturbed, volunteering for projects (such as the nest box program), recycling garbage and re-using as many items as possible, and walking or riding a bicycle instead of driving a car.

6. David Matheson and a group of volunteers built nest boxes for the ducks and nesting platforms for the great blue herons.

7. Gardeners add peat to their soil because it will increase the water-holding ability of their soil. This will help plants grow.

8. People who have a background in biology or environmental chemistry may be able to find employment with Ducks Unlimited as a habitat specialist.

9. **Textbook question 2 of "Check Your Understanding," on p. 305**

    2. Programs, such as the nest box program, are important because they provide safe nesting sites where natural nesting materials have been destroyed.

Section 4 Review

1. **Textbook question 1 of "Reviewing Key Terms," p. 306**

    1. a. False. An item that is **non-biodegradable** takes a long time to break down in the environment.

    b. False. Many people try to control the population of insects by spraying them with **insecticides**.

    c. True

    d. False. Applying fertilizer to a lawn or a field can lead to **eutrophication** in a pond or lake.

    e. True

    f. False. The **ozone layer** protects living things on Earth from harmful UV radiation.

    g. True

    h. True

i. True

j. True

k. True

2. **Textbook question 4 of "Understanding Key Ideas," p. 306**

4. The following steps show how using fertilizers can cause the eutrophication of a pond.

step 1: Run-off carries nitrates from lawns and farmers' fields to a pond.

step 2: Algae and surface plants grow quickly and block sunlight from deep-water plants.

step 3: The deep-water plants receive little or no sunlight and die off.

step 4: The decomposers have lots of food and multiply quickly.

step 5: Decomposition uses up the oxygen in the pond.

step 6: The lack of oxygen kills the fish and other water animals.

3. **Textbook question 8 of "Developing Skills," p. 307**

8. Your complete graph should be similar to the following.

The types of waste you could help reduce would be food and yard wastes and paper, since these are the largest percentage by weight of waste. Food and yard wastes can be composted, and paper can be recycled.

4. **Textbook question 9 of "Problem Solving/Applying," p. 307**

9. Answers will vary. Sample arguments for and against herbicide use is given.

For Herbicide Use

- Herbicides are necessary to maintain neat attractive lawns, thus increasing property values.
- Herbicides would not be on the market if they were not safe.

Against Herbicide Use

- Non-chemical methods could achieve the same results.
- Alternatives to lawns, such as well-maintained gardens, are more ecologically friendly.
- Herbicides accumulate in the food chain and show up in the environment later.

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